SCHOOL OF CIVIL ENGINEERING

JOINT HIGHWAY RESEARCH PROJECT

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ENGINEERING SOILS MAP OF MARION COUNTY

James C. Costello

PURDUE UNIVERSITY
INDIANA STATE HIGHWAY COMMISSION

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Final Report

ENGINEERING SOILS MAP OF MARION COUNTY

TO: J. F. McLaughlin, Director
Joint Highway Research Project

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

December 1, 1976

Project: C-36-51B

File: 1-5-2-59

The attached report, entitled "Engineering Soils Map of Marion County, Indiana", completes a portion of the project concerned with development of county engineering soils maps of the State of Indiana. This is the 59th report in the series. The report was prepared by Mr. James C. Costello, Graduate Instructor in Research, Joint Highway Research Project.

The soils mapping of Marion County was performed primarily by using the soil survey map sheets published by the Soil Conservation Service, United States Department of Agriculture in the soil survey of Marion County. Airphoto interpretation techniques were used to supplement the pedological data. The resulting engineering soils map is presented as a blackline print.

Respectfully submitted,

Harold L Michael

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Final Report

ENGINEERING SOILS MAP OF MARION COUNTY

by

James C. Costello
Graduate Instructor in Research

Joint Highway Research Project
Project No.: C-36-51B
File No.: 1-5-2-59

Prepared as Part of an Investigation

Conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with the

Indiana State Highway Commission

Purdue University
West Lafayette, Indiana
December 1, 1976

ENGINEERING SOILS MAP
OF
MARION COUNTY, INDIANA

INTRODUCTION

Development of an Engineering Soils Map of Marion County, Indiana was the primary goal of this project. The map is appended to this report; the report supplements the engineering soils map information.

The detailed pedological soils map published in the 1972 Interim Soil Survey of Marion County by the United States Department of Agriculture Soil Conservation Service in cooperation with the Purdue University, Agricultural Experiment Station (9) was the single most important source of data used in the project. These agricultural soils map sheets, at a scale of 1:15840, were assembled to form a mosaic map of Marion County. Careful study of the soil series descriptions enabled the grouping of the series into appropriate land form and parent material categories. Preliminary land form and parent material boundaries of interest to engineers and planners were then delineated on the mosaic map.

Routine airphoto interpretation techniques supplemented the pedological data. Aerial photographs were examined and the preliminary boundaries checked and modified, if necessary, to produce final land form and parent material boundaries. The photographs were contact prints at an approximate scale of 1:20,000. Date of photography was 1941.

The final land form and parent material boundaries were graphically reduced to produce the engineering soils map (1 inch = 1 mile). Symbols were used to delineate the parent material as grouped according to land form and origin. Textural symbols were superimposed to indicate the relative compositions of the parent materials. The map also includes a set of soil profiles which indicate, in general, the soil profiles of topographically high and low sites in the land form - parent material areas.

Each profile shows the general range in depth and texture of each horizon - the A-, B-, and C- horizons - the latter being the parent material. The soil texture classification system used in the map profiles is that of the Indiana State Highway Commission (the ISHC soil classification system chart is shown on the map in the lower right hand corner). The ISHC system differs slightly from the USDA system so that the use of USDA textures have to be converted to the ISHC textures - for example, a USDA classified loam could be a loam or a clay loam under the ISHC system.

The soil profiles portrayed on the engineering soils map have been numbered. Areas on the soils map have corresponding numbers to indicate the soil profile for that particular soil area.

In the text of the report, pedological soil names have been provided for each parent material soil area shown on the map. In Appendix A quantitative engineering soil test data is provided for each pedological soil name. In Appendix B quantitative data as to soil problems and certain advantageous soil

uses are provided according to pedological soil names. In Appendix C, soil boring data obtained from the construction of the interstate system within Marion County are provided (1). Appendix D contains information on the lithology of the bedrock surface throughout the county based on well logs (11).

DESCRIPTION OF THE AREA

General

Marion County is located in central Indiana (see Figure 1). Indianapolis, which is in the center of the county, is the largest city in Indiana and the fifth largest city in the nation not located on navigable water. It is the county seat of Marion County as well as the state capital.

Marion County is bounded on the north by Hamilton and Boone Counties, on the east by Shelby and Hancock, on the south by Johnson and Morgan and on the west by Hendricks County. It comprises an area of 256,000 acres or about 400 square miles (1035.5 square kilometers). Marion County has dimensions of approximately 20 miles (32.2 kilometers) both east-west and north-south (3).

Drainage Features

Drainage features of Marion County are shown in Figure 2, "Drainage Map - Marion County, Indiana", prepared by the Joint Highway Research Project, Purdue University, 1954 (16). Larger scale maps of one inch to the mile, or one inch to two miles, can be obtained by contacting Joint Highway Research Project,

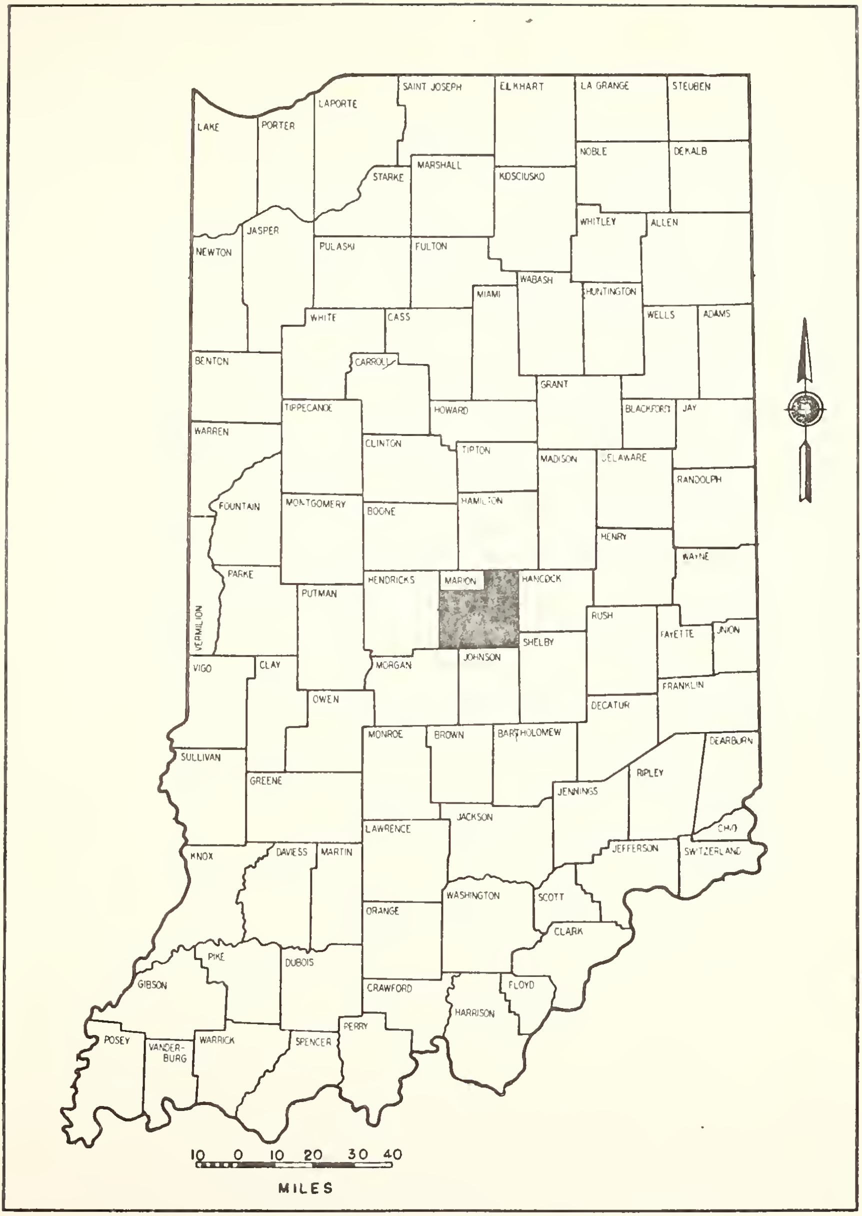


FIGURE 1: LOCATION MAP OF MARION CO.

School of Civil Engineering, Purdue University, West Lafayette, Indiana, 47907.

Interstate routes I-465, I-65, I-70, and I-74 were constructed after the drainage map was printed and, therefore, they do not appear on the drainage map. Undoubtedly drainage systems for the interstate produced numerous changes in the immediate vicinity and, of course, these do not show on the map. There has also been considerable other road construction and ditching to produce drainage changes since 1954.

The drainage of practically the entire county is directed into the West Fork of the White River. Eagle Creek enters the county near the northwest corner, flows southerly, and empties into the West Fork of the White River a few miles south of Indianapolis. Fall Creek enters the northeast corner of the county, flows southwest, and empties into the West Fork of the White River within the city limits. Several other smaller streams traverse portions of the county and join the river. Buck Creek which crosses the southeast corner of the county, flows into the East Fork of the White River.

Throughout those portions of the county where the topographic surface is gently rolling or rolling, or where there are gravel beds within four or five feet of the surface, the natural drainage is good. Where the surface is level, however, as is frequently the case throughout the uplands and within the flood plains, the natural drainage is often deficient. There are always numerous small depressions, formerly swamps, in which the natural drainage is poor. Tile drains and open

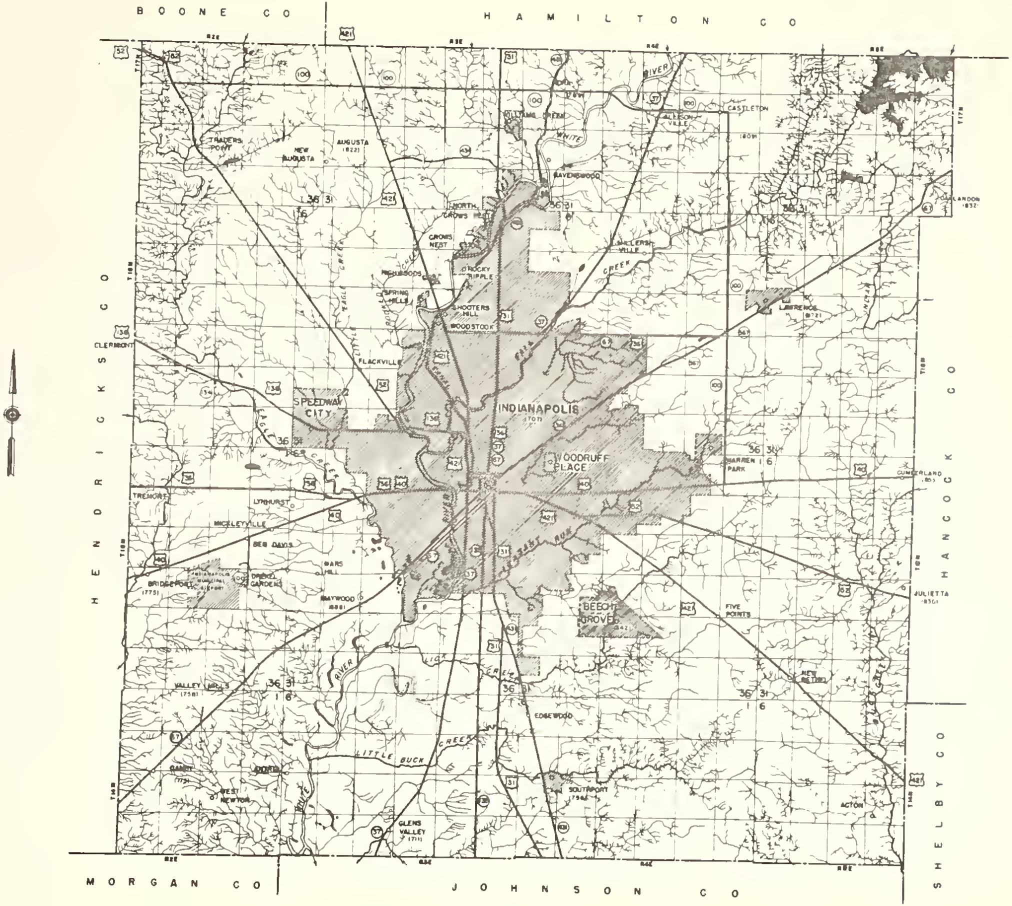


FIGURE 2: DRAINAGE MAP OF MARION COUNTY

ditches have been employed with marked success where the natural drainage is deficient. Practically all the swamps, none of which were of great extent, have been reclaimed.

Large man-made reservoirs have been developed on Fall Creek (Geist Reservoir) in the northeast and on Eagle Creek in the northwest.

Climatological Summary

The climate is continental, with rather warm summers, moderately cold winters and occasional wide variations in temperature, particularly during the colder seasons. Periods of humid, muggy weather occur during the summer although usually these Gulf air masses either do not push so far north or are soon replaced by cooler less humid air from northerly latitudes. Occasionally, hot, dry winds prevail from the west or southwest for several days. The longest and most severe heat was in July 1936, when the temperature climbed to 100° or more for nine consecutive days. Late spring and the fall season are usually very pleasant. Periods of two to three weeks of sunny days and mild temperatures are common during the fall.

Precipitation is normally adequate for good crops and is well distributed throughout the year. Rainfall of an inch or more in 24 hours occurs on an average of about once a month and lesser measurable amounts on about ten or twelve days. Snowfalls of three inches or more occur on an average of about two or three times during the winter.

Meteorological Data For The Current Year

Station INDIANAPOLIS, INDIANA WEIR COOK MUNICIPAL AIRPORT Standard time used EASTERN Latitude 39° 44' N Longitude 86° 17' W Elevation (ground) 792 feet Year 1975

Month	Temperature °F Averages Daily maximum	Daily minimum	Monthly	Extremes Highest	Date	Lowest	Date	Degree days Base 65 °F Heating	Cooling	Precipitation in inches Water equivalent Total	Greatest in 24 hrs.	Date	Snow, Ice pellets Total	Greatest in 24 hrs	Date	Relative humidity, pct Hour 01	Hour 07 (Local time)	Hour 13	Hour 19	Wind Resultant Direction	Resultant Speed m.p.h.	Average speed m.p.h.	Fastest mile Speed m.p.h.	Fastest mile Direction	Fastest mile Date	Percent of possible sunshine	Average sky cover, tenths, sunrise to sunset	Number of days Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperature °F Maximum (b) 90° and above	Maximum 32° and below	Minimum 32° and below	Minimum 0° and below	Average station pressure mb Elev 808 feet m.s.l.
JAN	39.7	24.3	32.0	65	29	6	20	1016	0	4.37	1.03	10	6.8	2.1	19	86	88	76	78	23	5.4	11.9	49	SW	10	38	7.8	4	7	20	16	2	4	2	0	8	27	0	988.5
FEB	38.8	25.2	32.0	55	21	-4	10	918	0	4.13	2.38	22-23	4.8	2.1	8-9	81	84	76	78	25	2.5	12.2	65	W	25	40	8.0	4	6	20	16	1	3	5	0	5	22	2	987.1
MAR	45.9	27.8	36.9	74	21	6	15	866	0	4.16	1.13	28-29	10.5	5.3	14	82	86	69	70	27	2.1	12.6	32	SW	25	52	7.7	4	7	20	20	2	7	2	0	2	19	0	985.8
APR	59.9	39.2	48.9	79	17	23	5	481	3	4.14	1.94	23-24	0.1	0.1	3	75	78	56	58	06	0.4	11.3	33	NW	3	57	6.3	7	8	15	11	0	7	0	0	0	10	0	988.5
MAY	76.5	54.4	65.5	88	24	42	13	78	100	2.42	0.78	30-31	0.0	0.0		84	88	58	61	22	1.2	8.9	49	W	26	68	6.4	7	10	14	10	0	6	0	0	0	0	0	985.4
JUN	81.2	61.7	71.5	91	20	46	8	22	222	5.73	3.73	25	0.0	0.0		90	92	67	65	21	3.5	9.6	32	SW	17	64	6.1	10	6	14	8	0	6	0	1	0	0	0	986.8
JUL	84.0	63.0	73.5	91	2	48	14	8	281	4.63	1.99	6-7	0.0	0.0		90	92	63	68	26	1.4	6.4	26	N	27	70	4.7	12	12	7	7	0	9	1	2	0	0	0	987.1
AUG	84.9	67.3	76.1	91	23	56	7	0	355	4.68	0.99	13	0.0	0.0		93	95	69	75	23	2.2	6.9	34	NW	17	60	6.4	6	9	16	13	0	10	2	4	0	0	0	989.2
SEP	72.4	52.7	62.6	90	3	39	13	137	71	2.32	1.50	11-12	0.0	0.0		90	95	64	73	30	0.6	7.4	28	NE	24	52	6.4	8	9	13	6	0	3	3	1	0	0	0	990.2
OCT	67.8	44.0	55.9	86	13	30	31	288	14	2.80	1.02	8	0.0	0.0		87	93	59	68	23	1.3	8.6	31	N	17	66	5.5	10	9	12	7	0	1	1	0	0	2	0	990.9
NOV	56.1	36.7	46.4	77	6	19	28	551	0	3.63	1.17	30	4.5	2.9	26	89	92	70	80	21	5.6	10.2	39	SW	20	51	6.2	7	9	14	11	2	3	0	0	0	14	0	989.5
DEC	39.5	26.0	32.8	67	14	7	10	992	0	3.71	1.45	15	8.1	4.8	25-26	87	90	80	86	24	1.9	10.0	33	SW	14	31	8.0	4	3	24	13	4	1	1	0	10	26	0	991.2
YEAR	62.2	43.4	52.8	91	AUG 23	-4	FEB 10	5357	1046	46.72	3.73	JUN 25	34.8	5.3	MAR 14	86	89	67	72	23	2.1	9.7	49	W	MAY 26	56	6.6	83	93	189	140	11	60	17	8	25	120	2	988.4

Normals, Means, And Extremes

Month	Temperatures °F Normal Daily maximum	Normal Daily minimum	Normal Monthly	Extremes Record highest	Year	Record lowest	Year	Normal Degree days Base 65 °F Heating	Cooling	Precipitation in inches Water equivalent Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs	Year	Snow, Ice pellets Maximum monthly	Year	Maximum in 24 hrs	Year	Relative humidity pct Hour 01	Hour 07 (Local time)	Hour 13	Hour 19	Wind Mean speed m.p.h.	Prevailing direction	Fastest mile ∅ Speed m.p.h.	Direction	Year	Pct of possible sunshine	Mean sky cover tenths sunrise to sunset	Mean number of days Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperatures °F Max (b) 90° and above	Max 32° and below	Min 32° and below	Min 0° and below	Average station pressure mb. Elev 808 feet m.s.l.
(a)				17		17					36		36		33		44		33		16	16	16	16	27	14	31	31		32	33	44	44	44	36	34	33	33	16	16	16	15	3
J	36.0	19.7	27.9	70	1967	-20	1972	1150	0	2.86	12.69	1950	0.21	1944	3.47	1950	17.0	1968	10.3	1965	77	80	69	71	11.1	NW	90	W	1950	41	7.2	6	6	19	11	2	1	4	0	13	27	4	959.6
F	39.3	22.1	30.7	74	1972	-10	1965	960	0	2.36	5.35	1971	0.37	1947	2.38	1975	15.3	1965	12.5	1965	76	79	66	69	11.2	WNW	65	SW	1948	51	6.9	6	6	16	10	2	1	2	0	8	25	1	988.1
M	49.0	30.3	39.7	80	1974	-6	1960	784	0	3.75	10.74	1963	1.03	1941	3.05	1963	10.5	1975	5.6	1948	75	79	63	65	11.9	WNW	68	NW	1947	51	7.1	5	6	18	13	1	3	2	0	3	18	*	985.3
A	62.8	41.8	52.3	89	1970	18	1972	387	6	3.87	8.09	1964	1.07	1946	2.56	1961	4.0	1940	3.1	1953	72	77	55	57	11.5	SW	60	W	1956	55	7.0	6	7	17	12	*	5	1	0	0	6	0	986.4
M	72.9	51.5	62.2	93	1965	28	1966	159	72	4.08	10.10	1943	1.42	1964	3.53	1961	T	1966	T	1966	78	82	57	58	9.7	SW	68	W	1951	61	6.5	7	9	15	12	0	7	1	1	0	1	0	984.3
J	82.3	61.1	71.7	96	1962	42	1969	11	212	4.16	9.74	1942	1.07	1967	3.80	1963	0.0		0.0		80	82	56	59	8.5	SW	77	N	1946	68	6.1	7	11	12	10	0	8	1	4	0	0	0	985.8
J	85.4	64.6	75.0	99	1970	48	1975	0	310	3.67	8.11	1958	0.99	1941	4.18	1973	0.0		0.0		83	87	60	62	7.4	SW	57	W	1957	70	5.8	8	13	10	9	0	8	1	6	0	0	0	987.5
A	84.0	62.4	73.2	97	1964	41	1965	5	259	2.80	6.64	1949	0.68	1964	2.72	1949	0.0		0.0		86	90	61	65	7.2	SW	54	NW	1946	71	5.4	10	12	9	8	0	6	2	3	0	0	0	988.9
S	77.7	54.9	66.3	96	1964	34	1974	63	102	2.87	6.01	1955	0.24	1953	3.07	1961	0.0		0.0		84	90	59	66	8.1	SW	61	NW	1952	66	5.4	11	8	11	8	0	4	1	2	0	0	0	989.6
O	67.0	44.3	55.7	88	1971	20	1962	302	13	2.51	8.36	1941	0.17	1963	3.90	1959	1.2	1962	1.2	1962	80	87	57	64	8.9	SW	56	NW	1952	64	5.2	12	8	11	8	*	2	1	0	0	4	0	991.3
N	50.5	32.8	41.7	78	1961	4	1959	699	0	3.10	5.65	1972	0.89	1949	3.02	1955	8.3	1966	8.2	1966	81	85	67	73	10.7	SW	59	SW	1948	42	6.9	7	7	16	10	1	1	2	0	1	15	0	969.0
D	38.7	23.1	30.9	70	1970	-14	1963	1057	0	2.71	6.70	1957	0.47	1958	2.21	1971	27.5	1973	11.5	1973	81	83	73	77	10.5	SW	56	SW	1971	39	7.3	5	6	20	12	2	*	3	0	10	25	1	989.0
YR	62.2	42.4	52.3	99	JUL 1970	-20	JAN 1972	5577	974	38.74	12.69	JAN 1950	0.17	OCT 1963	4.18	JUL 1973	27.5	DEC 1973	12.5	FEB 1965	79	83	62	65	9.7	SW	90	W	JAN 1950	56	6.4	90	101	174	123	7	45	21	19	35	120	7	987.0

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 107 in July 1934; lowest temperature -25 in January 1884; maximum monthly precipitation 13.12 in July 1875; minimum monthly precipitation 0.07 in March 1910; maximum precipitation in 24 hours 6.80 in September 1895; maximim monthly snowfall 30.4 in March 1906; fastest mile of wind 111 from Northwest in June 1929.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace.

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.

∅ Beginning with 1943 but omitting 1962 and 1963.

Average Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1936	21.4	21.2	43.8	47.0	65.0	71.2	82.0	79.5	69.8	54.5	39.4	34.7	52.4
#1937	32.6	29.8	36.7	49.8	61.6	70.4	74.0	76.0	63.6	51.6	37.7	28.2	51.0
1938	28.2	37.6	46.0	52.8	61.6	69.0	75.4	75.4	67.7	57.0	42.4	31.6	53.8
1939	33.2	31.0	41.8	47.2	64.8	72.9	74.7	72.8	70.7	55.7	40.0	33.4	53.3
1940	14.2	30.8	34.8	47.5	57.8	71.2	75.6	75.6	64.9	58.6	39.8	36.4	50.8
1941	29.4	26.3	35.2	56.8	63.6	71.5	76.0	74.3	69.8	58.2	43.0	36.6	53.4
1942	27.7	27.4	47.0	55.3	62.2	71.4	75.1	72.1	64.4	54.8	44.0	26.2	51.9
1943	28.7	31.7	35.8	47.7	61.2	74.8	75.8	74.5	61.8	53.4	37.9	28.6	51.0
1944	32.6	33.0	36.8	49.8	67.4	74.0	75.8	74.2	66.0	54.0	43.0	25.3	52.6
1945	22.8	32.0	51.2	52.6	56.4	68.1	72.4	72.1	67.4	52.2	42.2	23.9	51.1
1946	29.0	33.0	51.9	53.0	59.2	70.5	74.8	69.0	66.2	59.0	45.2	35.4	53.8
1947	33.7	22.5	37.8	50.6	58.3	68.0	70.6	79.0	66.4	62.4	37.8	31.6	51.1
1948	21.0	31.0	41.2	54.0	60.8	71.3	74.5	73.6	67.4	51.2	44.6	34.3	52.0
1949	34.0	35.0	41.0	50.2	63.1	73.4	78.2	73.6	60.6	59.2	42.3	35.8	53.9
1950	37.4	31.6	36.8	45.9	63.6	68.6	72.3	70.2	64.6	59.2	36.4	23.4	50.8
1951	29.1	30.7	37.8	48.4	63.9	69.9	74.1	72.0	62.6	57.0	35.6	30.6	51.0
1952	33.1	35.3	39.8	52.0	61.1	76.6	76.7	73.0	66.0	49.8	42.9	34.9	53.4
1953	32.9	35.6	47.1	47.7	64.6	75.9	75.9	74.3	67.2	58.4	43.6	32.8	54.3
1954	30.8	40.1	37.4	57.4	57.9	75.5	77.8	73.6	69.6	55.9	42.1	32.2	54.2
1955	27.5	32.2	40.6	57.1	63.6	67.1	79.4	75.9	68.9	54.7	37.6	28.7	52.8
1956	27.2	33.5	40.2	48.9	62.5	72.1	72.9	73.0	63.8	60.7	41.1	38.8	52.9
1957	23.5	36.5	40.8	53.3	62.1	72.1	75.4	73.4	64.6	51.4	40.7	36.2	52.5
1958	26.1	23.7	35.9	52.2	61.3	66.8	73.5	71.9	65.5	54.9	43.6	24.2	50.2
#1959	24.9	31.7	38.8	51.7	65.7	73.0	75.2	77.3	68.4	53.8	35.5	35.9	52.7
1960	31.8	28.1	26.2	54.8	56.8	68.5	71.6	74.1	69.8	54.7	42.3	24.6	50.4
1961	23.6	34.0	43.6	45.6	56.4	67.9	73.4	71.4	70.9	56.2	42.0	29.1	51.2
1962	23.7	30.7	37.7	51.1	69.2	73.2	73.3	72.4	62.6	56.7	42.4	25.5	51.5
1963	19.5	21.1	42.4	53.3	59.7	71.3	73.4	68.9	63.4	62.1	45.1	18.5	50.0
1964	30.7	29.0	40.6	54.7	65.6	73.4	74.6	72.5	67.2	51.7	45.3	32.2	53.1
1965	27.5	29.5	33.7	54.4	68.3	71.7	72.9	71.1	67.5	53.7	44.7	38.6	52.8
1966	22.4	30.4	43.3	51.3	58.4	72.4	79.2	73.2	65.2	51.9	43.8	32.7	52.0
1967	32.6	27.7	44.0	53.6	59.3	73.9	73.8	71.1	65.9	55.2	39.4	33.7	52.5
1968	25.1	26.4	42.8	53.7	58.6	72.3	75.3	74.5	65.8	54.4	42.9	30.6	51.9
1969	25.7	31.7	35.7	54.0	63.4	69.6	75.8	72.7	65.2	53.8	37.5	28.2	51.1
1970	17.9	28.6	38.1	55.1	65.6	71.5	75.2	74.2	69.1	55.2	40.9	34.7	52.2
1971	23.4	28.9	37.3	51.0	58.9	75.6	72.3	71.3	69.4	62.0	43.1	38.4	52.7
1972	26.5	28.4	39.8	52.1	65.0	68.8	74.6	73.1	68.3	51.5	39.9	31.9	51.7
1973	30.7	31.5	49.4	51.3	59.5	73.3	76.0	74.4	69.9	59.4	46.4	30.9	54.4
1974	31.6	32.4	45.3	53.0	62.1	66.6	76.0	71.8	60.6	52.5	42.5	32.9	52.6
1975	32.0	32.0	36.9	48.9	65.5	71.5	73.5	76.1	62.6	55.9	46.4	32.8	52.8
RECORD MEAN	28.5	30.8	40.1	52.0	62.5	71.8	75.7	73.7	66.9	55.5	42.0	31.9	52.6
MAX	36.2	38.8	48.9	61.6	72.4	81.6	85.6	83.6	77.1	65.5	50.1	39.0	61.7
MIN	20.7	22.8	31.3	42.3	52.3	61.9	65.7	63.7	56.7	45.4	33.8	24.7	45.5

Heating Degree Days

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1955-56	0	0	29	327	820	1119	1144	906	763	483	162	42	5510
1956-57	0	7	104	143	711	808	1280	793	742	396	131	9	5124
1957-58	0	2	90	416	721	888	1136	1150	897	365	141	28	5834
1958-59	2	6	77	318	640	1257	1239	925	803	397	104	6	5774
#1959-60	0	3	54	371	878	885	1027	1064	1198	333	214	24	6051
1960-61	0	0	28	316	674	1245	1275	861	657	580	268	35	5939
1961-62	0	3	60	276	684	1108	1272	957	839	441	41	2	5683
1962-63	3	2	142	266	673	1221	1406	1222	691	352	185	16	6179
1963-64	0	20	71	117	590	1437	1056	1037	750	308	64	11	5461
1964-65	2	16	73	405	581	1009	1155	989	964	323	39	0	5556
1965-66	0	18	66	355	603	811	1312	962	668	412	223	11	5441
1966-67	0	0	77	407	631	985	997	1045	652	353	219	2	5368
1967-68	3	9	83	327	761	964	1232	1112	680	333	205	11	5720
1968-69	4	13	49	354	656	1057	1211	925	904	329	121	35	5661
1969-70	0	0	89	359	816	1137	1458	1012	629	316	95	11	6117
1970-71	4	0	51	301	715	930	1281	1006	852	417	198	0	5755
1971-72	3	1	49	129	648	913	1186	1054	774	389	69	35	5170
1972-73	8	4	36	413	745	1018	1059	937	477	416	184	0	5298
1973-74	0	0	20	211	552	1052	1026	905	617	314	158	18	4875
1974-75	0	5	163	380	671	988	1016	918	866	481	78	22	5588
1975-76	8	2	137	268	551	992							

Cooling Degree Days

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1969	0	0	0	5	78	190	344	245	95	18	0	0	975
1970	0	0	0	26	122	213	327	292	182	5	0	0	1167
1971	0	0	0	2	17	324	237	202	189	40	0	0	1011
1972	0	0	0	8	95	156	313	266	141	0	0	0	979
1973	0	0	0	11	20	256	349	302	172	44	1	0	1155
1974	0	0	11	19	73	131	346	225	40	3	2	0	850
1975	0	0	0	3	100	222	281	355	71	14	0	0	1046

Precipitation

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1936	1.29	2.83	2.31	4.19	1.49	3.41	0.61	2.88	5.12	3.62	4.85	3.10	35.70
#1937	8.76	1.69	1.53	4.86	2.17	4.32	4.70	3.84	3.46	6.52	1.86	3.83	47.54
1938	0.99	2.75	8.11	3.69	6.07	7.53	7.30	4.70	1.98	1.06	3.59	1.47	49.23
1939	6.72	3.16	3.22	5.85	0.48	5.49	5.09	1.75	1.13	2.91	1.57	1.43	38.80
1940	1.52	2.31	1.11	6.14	3.45	1.77	1.28	2.45	1.49	0.94	3.29	2.66	28.41
1941	1.72	0.56	1.03	2.01	1.93	3.13	0.99	1.67	1.78	10.36	2.19	1.59	28.96
1942	1.05	3.58	3.85	2.49	4.80	9.74	2.95	3.43	2.68	0.98	5.22	1.71	42.48
1943	0.65	1.01	3.30	1.74	10.10	3.29	3.02	2.42	3.26	1.37	1.94	1.05	33.15
1944	0.21	2.62	4.20	7.90	3.33	2.32	1.99	1.98	2.31	0.61	2.19	1.11	30.97
1945	0.57	2.59	7.76	5.11	4.15	8.12	4.06	2.80	5.61	2.04	3.19	2.49	48.49
1946	1.44	2.31	3.62	1.07	7.13	2.37	1.58	2.52	1.00	1.54	3.27	3.03	31.08
1947	4.06	0.37	1.95	5.62	3.91	5.67	2.33	5.22	3.45	2.44	1.44	1.61	38.27
1948	2.52	1.62	6.32	3.44	3.25	4.24	3.36	1.04	3.03	2.12	4.93	3.16	39.26
1949	7.41	2.38	3.16	1.62	2.75	4.18	2.95	6.64	2.52	4.25	0.89	4.32	43.07
1950	12.69	5.32	3.89	3.44	2.66	6.55	2.15	4.08	4.96	0.98	5.52	3.00	55.25
1951	2.95	3.76	3.16	3.26	2.78	5.77	3.12	2.43	2.39	3.28	5.21	4.68	42.79
1952	3.69	2.71	5.77	3.99	3.90	6.17	2.45	2.46	4.62	0.64	3.87	3.01	43.28
1953	2.57	1.93	5.41	3.18	4.50	4.86	6.19	1.76	1.44	1.70	2.29	2.42	38.25
1954	3.40	2.64	2.99	2.34	1.98	1.15	2.40	2.73	0.96	3.92	1.32	2.10	27.93
1955	2.09	2.34	2.26	3.31	3.37	1.79	3.24	1.21	6.01	4.27	5.32	0.70	37.91
1956	1.05	3.99	1.99	4.50	4.91	3.48	3.93	2.55	1.07	1.09	2.31	3.86	34.64
1957	2.98	1.85	1.97	7.83	9.15	6.91	5.91	3.89	2.22	2.94	3.40	6.70	55.70
1958	1.46	0.41	1.49	2.51	3.65	6.09	5.11	3.12	3.35	2.72	4.71	0.47	35.11
1959	4.68	3.22	2.58	3.52	3.67	2.30	2.97	2.56	2.33	5.66	3.21	2.91	39.61
1960	2.35	3.28	1.62	2.05	4.04	7.26	3.27	1.78	2.43	1.61	1.68	1.88	33.27
1961	1.22	3.15	7.91	6.68	6.46	3.47	2.61	2.70	4.40	1.27	3.72	3.05	46.64
1962	4.58	2.27	4.01	1.69	5.14	1.45	6.87	5.78	4.13	2.83	1.42	1.09	41.26
1963	1.15	0.58	10.74	2.58	2.10	5.30	4.66	2.22	0.24	0.17	2.18	0.65	32.78
1964	2.04	2.01	7.20	8.09	1.42	2.73	4.09	0.68	1.27	0.64	3.13	3.05	36.35
1965	3.86	4.33	2.17	5.80	1.44	3.49	3.18	3.25	5.16	1.05	1.41	2.97	38.11
1966	1.13	2.91	1.31	3.32	1.47	1.28	2.71	1.31	5.73	1.60	4.72	3.23	32.72
1967	1.81	1.84	3.33	3.00	5.00	1.07	2.34	2.35	0.80	5.72	2.54	4.92	34.75
1968	2.96	1.51	3.73	2.86	9.25	2.51	2.19	4.45	1.54	1.13	4.74	4.18	41.05
1969	6.19	1.23	1.33	4.42	1.82	4.16	8.02	2.98	2.89	4.83	2.86	2.04	42.77
1970	1.17	1.86	2.51	6.53	2.43	1.97	4.43	1.87	2.41	3.66	2.12	2.07	32.98
1971	1.98	5.35	1.49	1.16	4.25	3.39	5.68	1.93	3.10	1.84	1.29	6.02	37.48
1972	1.57	1.15	2.48	5.81	1.89	6.04	2.01	2.94	5.65	2.25	5.65	2.83	40.27
1973	2.27	1.11	5.63	2.76	1.79	5.91	6.67	2.74	2.43	3.11	3.62	4.27	42.31
1974	3.39	2.58	3.00	3.45	6.27	5.15	1.20	5.63	3.25	0.99	2.99	2.81	41.31
1975	4.37	4.13	4.16	4.14	2.42	3.73	4.63	4.68	2.32	2.80	3.63	3.71	46.72
RECORD MEAN	2.99	2.54	3.82	3.72	3.88	4.11	3.78	3.18	3.19	2.66	3.19	2.92	39.98

Snowfall

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1936-37	0.0	0.0	0.0	0.0	T	3.8	3.4	2.2	6.1	0.2	0.0	0.0	15.7
#1937-38	0.0	0.0	0.0	0.0	3.1	4.6	3.0	1.9	T	1.2	0.0	0.0	13.8
1938-39	0.0	0.0	0.0	0.0	6.4	1.9	15.0	7.1	0.2	T	0.0	0.0	30.6
1939-40	0.0	0.0	0.0	0.0	0.3	6.6	3.9	10.3	0.4	4.0	T	0.0	25.5
1940-41	0.0	0.0	0.0	0.0	T	T	2.7	3.7	1.0	0.0	0.0	0.0	7.4
1941-42	0.0	0.0	0.0	0.0	2.3	0.3	0.2	3.4	3.3	T	0.0	0.0	9.5
1942-43	0.0	0.0	0.0	0.0	4.1	7.8	4.1	2.1	3.1	T	0.0	0.0	21.2
1943-44	0.0	0.0	0.0	0.0	0.2	5.0	T	8.8	3.3	T	0.0	0.0	17.3
1944-45	0.0	0.0	0.0	0.0	0.4	5.1	9.2	2.6	T	T	0.0	0.0	17.3
1945-46	0.0	0.0	0.0	0.0	1.0	8.2	3.9	1.7	1.5	T	0.0	0.0	16.3
1946-47	0.0	0.0	0.0	0.0	0.0	3.3	0.9	5.5	9.5	T	0.0	0.0	19.2
1947-48	0.0	0.0	0.0	0.0	0.2	4.7	4.1	5.9	5.6	0.0	0.0	0.0	20.5
1948-49	0.0	0.0	0.0	0.0	0.5	5.6	1.2	T	5.1	T	0.0	0.0	12.4
1949-50	0.0	0.0	0.0	0.0	T	0.6	1.3	3.9	0.4	T	0.0	0.0	6.2
1950-51	0.0	0.0	0.0	0.0	3.8	7.0	10.8	4.0	7.0	0.1	0.0	0.0	32.7
1951-52	0.0	0.0	0.0	T	4.0	6.8	0.7	2.1	2.0	0.1	0.0	0.0	15.7
1952-53	0.0	0.0	0.0	0.0	1.3	6.9	4.5	0.3	7.5	3.1	0.0	0.0	23.6
1953-54	0.0	0.0	0.0	0.0	3.9	4.2	5.7	1.6	1.4	T	0.0	0.0	16.8
1954-55	0.0	0.0	0.0	T	5.0	2.4	4.4	4.5	3.7	T	0.0	0.0	20.0
1955-56	0.0	0.0	0.0	T	3.9	3.3	11.6	3.8	9.0	0.8	0.0	0.0	32.4
1956-57	0.0	0.0	0.0	0.0	2.7	3.2	7.6	1.1	T	3.7	0.0	0.0	18.3
1957-58	0.0	0.0	0.0	T	T	3.4	4.0	0.6	1.3	T	T	0.0	9.3
1958-59	0.0	0.0	0.0	0.0	4.6	1.4	5.2	1.0	10.1	0.0	0.0	0.0	22.3
1959-60	0.0	0.0	0.0	0.0	3.3	2.8	T	9.2	9.3	T	T	0.0	24.6
1960-61	0.0	0.0	0.0	0.0	T	6.2	3.6	14.3	0.4	2.7	0.0	0.0	27.2
1961-62	0.0	0.0	0.0	0.0	0.5	6.2	5.1	14.0	1.7	T	0.0	0.0	27.5
1962-63	0.0	0.0	0.0	1.2	0.2	6.1	9.0	6.8	6.1	0.0	0.0	0.0	29.4
1963-64	0.0	0.0	0.0	0.0	0.3	7.8	9.2	12.7	4.1	0.2	0.0	0.0	34.3
1964-65	0.0	0.0	0.0	0.0	2.6	1.1	12.2	15.3	5.3	T	0.0	0.0	36.5
1965-66	0.0	0.0	0.0	0.0	T	2.9	2.3	6.3	0.8	T	T	0.0	12.3
1966-67	0.0	0.0	0.0	0.0	8.3	3.3	2.4	8.1	3.0	0.0	0.0	0.0	25.1
1967-68	0.0	0.0	0.0	T	6.3	3.5	17.0	1.1	8.8	T	0.0	0.0	36.7
1968-69	0.0	0.0	0.0	0.0	0.6	1.6	9.3	0.8	6.4	T	0.0	0.0	18.7
1969-70	0.0	0.0	0.0	0.0	2.5	12.9	7.8	9.2	5.6	0.2	0.0	0.0	38.2
1970-71	0.0	0.0	0.0	0.0	0.2	0.4	1.5	8.2	2.6	T	0.0	0.0	13.1
1971-72	0.0	0.0	0.0	0.0	4.4	0.4	7.9	6.3	0.3	0.6	0.0	0.0	19.9
1972-73	0.0	0.0	0.0	T	1.9	1.1	0.4	1.4	2.0	1.1	0.0	0.0	7.9
1973-74	0.0	0.0	0.0	0.0	0.4	27.5	3.8	8.0	3.0	2.1	0.0	0.0	44.8
1974-75	0.0	0.0	0.0	0.0	3.8	5.8	6.8	4.8	10.3	0.1	0.0	0.0	31.6
1975-76	0.0	0.0	0.0	0.0	4.5	8.1							
RECORD MEAN	0.0	0.0	0.0	T	2.2	4.8	4.9	5.1	3.8	0.5	T	0.0	21.3

# Indicates a station move or relocation of instruments. See Station Location table.

Record mean values above are means through the current year for the period beginning in 1871 for temperature and precipitation, 1932 for snowfall. Data are from city locations through July 1931.

STATION LOCATION

Location	Occupied from	Occupied to	Airline distance and direction from previous location	Latitude	Longitude	Elevation above										Remarks
						Sea level	Ground								Sea level	
				North	West	Ground at temperature site	Wind instruments	Extreme thermometers	Psychrometer	Telepsychrometer	Tipping bucket rain gage	Weighing rain gage	8" rain gage	Hygrothermometer	Pyranometer	
CITY																
Blackfords Block, SE Corner Washington and Meridan Streets	2/04/71	4/30/81		39° 46'	86° 10'		91	47	47		74		74			
Saks Building, SW Corner Washington & Penn.	4/30/81	9/01/96	1 block E	39° 46'	86° 10'		90	52	52		74		74			Thermometers raised to 75 feet 5/1/85 (from window to roof).
Majestic Building, NE Corner Pennsylvania and Maryland Streets	9/01/96	7/01/15	1 block SSE	39° 46'	86° 10'	710	167	154	154		146		146			
Consolidated Building 115 N. Pennsylvania St.	7/01/15	10/28/38	2-1/2 blocks N	39° 46'	86° 10'	715	232	184	184		188		188			
Federal Building	10/28/38	10/01/54	1-1/2 blocks NNW	39° 46'	86° 10'	718	131	98	98		a96	86	86			a - This gage moved to Airport 1/1/43.
AIRPORT																
Airport Admn. Building Weir Cook Municipal AP 6.7 miles WSW of P. O.	4/01/31	5/01/41		39° 44'	86° 16'	783	52	A5	A5				B4			A - 46' to 10/19/37. B - 33' to 10/19/37.
Roscoe Turner Hangar Building, Weir Cook Municipal Airport	5/01/41	6/14/65	500 feet S	39° 44'	86° 18'	e782	c20	5	5	b6	a29	4	4	d5	f837	a - Installed 1/1/43. b - 12/24/54 to 9/1/59. c - 54' to 64' prior to installation on field site 11/9/59. d - Commissioned 1500' W of telepsychrometer site 9/1/59, moved 300' NE 9/11/61 and 2800' WNW 12/21/62. e - 793' to 12/21/62. f - 800' to 9/62.
Building #1, Weir Cook Municipal Airport	8/14/85	Present	2600 feet NW	39° 44'	86° 17'	792	20	5	5		28	5	4	5	822 g	Wind sensors and hygrothermometer not moved 6/14/65. g - Decommissioned 12/31/74.

The average freeze free period extends from April 23 to October 22. However, freezing has occurred as late as May 27 and as early as September 27.

The following charts aid in summarizing the climatological information of Marion County, Indiana (5).

Glacial Geology

The configuration of the ground surface of Marion County and the composition of the materials that underlie it are the results of the last major glaciation of central Indiana. It is estimated that ninety to one hundred cubic miles of ice covered the county at the height of the last (Champaign) advance of the East White Sublobe, about 20,000 years ago (11).

The Champaign ice upon melting deposited a layer of drift one to fifty or more feet (0-17 meters) thick. The major valleys of Marion County were formed by streams of melt water flowing in ice walled channels; numerous minor valleys, on the other hand, originated when streams flowing parallel to decaying ice margins cut into the drift surface.

About 80 percent of the virgin surface of Marion County consists of hummocky moraine of low relief (0-3 meters) which exhibits closed ice disintergration ridges, till hummocks, kames and linear ridges (composed of till or stratified drift).

Outwash plains and terraces constitute about 15 percent of the surface, and the remaining five percent is composed of post glacial alluvium.

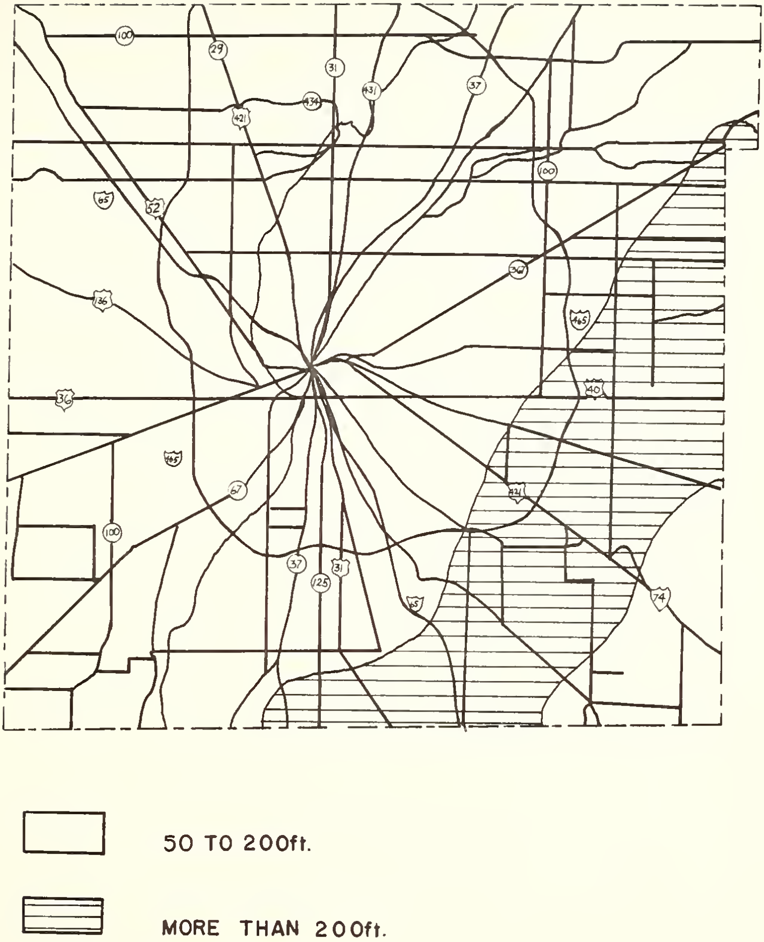


FIGURE 3: GLACIAL DRIFT THICKNESS — MARION COUNTY

The total accumulation of glacial drift in Marion County is believed to be composed of three drift sheets that resulted from the Kansan, Illinoian and Wisconsin glaciations. Drift thickness range from less than 15 feet (5 meters) to greater than 400 feet (134 meters); average thickness for the entire county, based upon 575 datum points is 140 feet (46 meters). See Figure 3 (11).

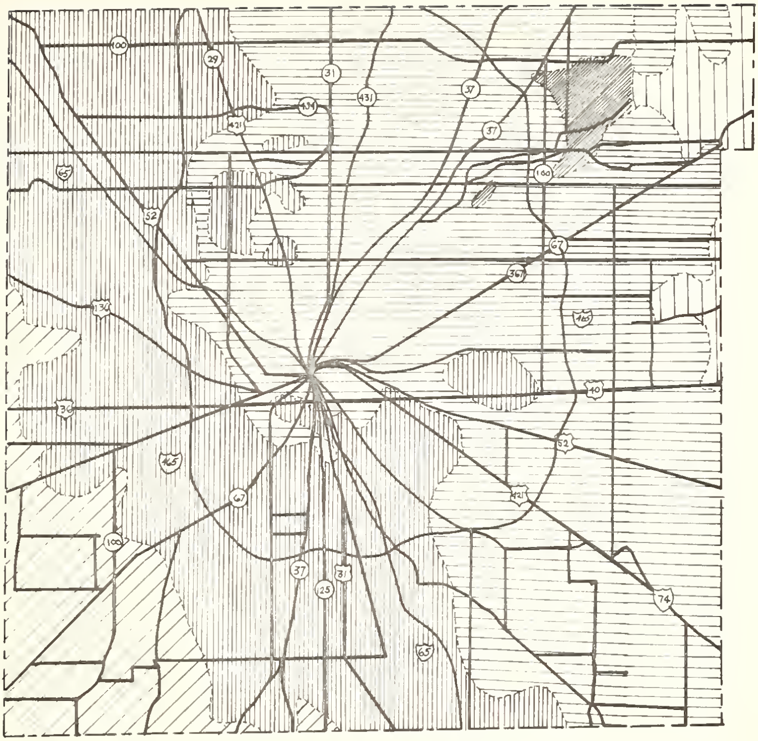
Glacial materials older than Kansan in age have not been identified in well logs and probably are absent beneath Marion County. It is assumed that the Kansan is the oldest drift sheet beneath Marion County and that its base is in contact with the preglacial bedrock surface.

Well logs from Marion County are provided in Appendix D. Triangular symbols on the engineering soils map denote well log sites.

The various glacial advances, namely Kansan, Illinoian and Wisconsin are delineated as accurately as possible in this data. A typical example is well log #2, in which a Wisconsin stage, Illinoian stage and Pre-Illinoian (possibly Kansan stage) is delineated.

Bedrock Geology

Marion County includes three distinct geological formations. The eastern portion of the county is underlain by Carboniferous limestone 60 to 100 feet (20-34 meters) below the surface. Two miles west of the city of Indianapolis, the limestone is underlain by black Genesee shale, which has a thickness of 40 feet (13 meters). In the extreme southwest corner of the county the



▨ SILURIAN — ROCKS OF SILURIAN AGE
LIMESTONE, DOLOMITE, AND SHALE

▨ MISSISSIPPIAN — LOWERMOST PART OF HARRODSBURG LIMESTONE
BORDEN GROUP, AND ROCKFORD LIMESTONE
SILTSTONE, SHALE, SANDSTONE, AND SOME LIMESTONE

▤ DEVONIAN — ROCKS OF MIDDLE DEVONIAN AGE
MOSTLY LIMESTONE AND DOLOMITE

▥ DEVONIAN AND MISSISSIPPIAN — NEW ALBANY SHALE
MOSTLY BLACK SHALE

▥ SILURIAN — ROCKS OF SILURIAN AGE
LIMESTONE, DOLOMITE, AND SHALE, M, BASE OF MISSISSINEWA
SHALE MEMBER, W, BASE OF WALDRON SHALE

FIGURE 4: BEDROCK GEOLOGY OF MARION COUNTY

Genesee shale is overlain by the Knob sandstone. These rock formations are covered to a depth of from 50 to 400 feet (17 - 134 meters) by a deposit of glacial or fluvial drift which forms the surface of the county and determines the character of soils (7, 8). See Figure 4 for a graphical representation of Marion County's bedrock geology.

In Appendix D, more detailed data is available concerning specific locations within Marion County. These well logs delineate the bedrock of the county to depths as great as 1266 feet (422 meters) as portrayed by well #21.

Physiography and Topography

Marion County lies in the Central Lowlands province of the United States and is in the Till Plains section of the province. In Indiana, the till plains area is known as the Tipton Till Plains.

The average elevation of the county above sea level is 860 feet (288 meters) and occasionally an elevation of 900 feet (300 meters) is reached. The mean relief of the land above the valley of the West Fork of the White River is 175 feet (58 meters).

In topography the surface varies from level to gently rolling or rolling. That portion of the area which lies within the bottoms along the West Fork of the White River is level, with occasional slight undulations, and about one third of the remainder of the area is also level or undulating. The level stretches in the upland, which vary in size from one to four or five square miles (10-13 square kilometers), are surrounded by and gradually grade into gently rolling and rolling lands.

The roughest topography is found along Eagle Creek in the northwestern corner of the county. Here, a few of the slopes are too steep to be cultivated. Other limited areas of broken land are found at intervals along Eagle Creek, Fall Creek and White River.

Central Marion County is crossed from northwest to southeast by a belt of undulating drift about ten miles (16 kilometers) wide, its surface lying at an elevation of about 800 feet (270 meters) above sea level. This low moraine is bordered on the south by massive gravel ridges and other morainic or ice contact features. Through this belt and nearly at right angles, the West Fork of the White River and Fall Creek cut a trench about 200 feet (70 meters) deep, having its bottom on or near bedrock. During the period of glacial retreat this trench was filled with gravelly outwash. A readvance of the ice margin, accompanied by the escape of subglacial streams, deposited near the western border of the outwash plain a belt of sand and gravel hills three miles long and rising in the sharp knob of Crown Hill 90 feet (30 meters) above the plain and 150 feet (50 meters) above the river (7). The West Fork of the White River passes through the moraine in a gorge three miles long and half a mile wide, bordered by steep bluffs 40-80 feet (13-27 meters) high. This gravel outwash plain about three miles wide is bounded on the east by a gentle rise or bluff 15-30 feet (5-10 meters) high, which parallels Fall Creek and touches the West Fork of the White River at the mouth of

Pleasant Run, below which the plain lies on the west side. The outwash plain surface slopes from an elevation of about 740 feet (247 meters) in the north to 680 feet (227 meters) in the south, or about six feet to the mile. The plain is cut by the high water channels of the West Fork of the White River, Fall Creek and Eagle Creek, into a series of low but well defined terraces. The city of Indianapolis occupies the gravel outwash plain, the kame moraine and the bluffs and flood plain of the West Fork of the White River, and extends on the east and south several miles beyond the bluff over the more elevated undulating drift. Detailed mapping of this area is somewhat restricted by the cultural pattern.

ENGINEERING SOIL AREAS

The parent materials of Marion County can be divided in four major groups:

1. Glacial drift or ice contact deposits
2. Fluvial drift
3. Eolian drift and
4. Cumulose drift

In the discussion that follows, each of the major groups is further subdivided into land form-parent material groups. These groups are further subdivided into soil textural groups for which pedological names are provided. Using the pedological names and Appendices A and B, engineering properties and problems for various soil areas can be obtained.

Glacial Deposited Materials

The land forms of glacial drift or ice contact deposits in Marion County include ground moraine, kame moraine and kames and eskers.

1. Ground moraine - silty clay texture (soil profile set #1 on map)

The largest area of land form-parent material in the county is a ground moraine. This ground moraine of Wisconsin age covers about four fifths of the county to the east, north and west of Indianapolis.

At the base of the drift formation is usually found a compact lead colored clay. Occasionally there may be found thin deposits of very fine gray or yellow sand. Between the clay and the rock on which it rests is generally found a layer of coarse gravel or small siliceous boulders. In Marion County this clay bed ranges from 20 to 100 feet (7-34 meters) in thickness and is very uniform in character throughout, except where the light strata of fine sand occurs. Above this is generally found a few feet of coarse sand or fine gravel.

The lower blue clay represents an earlier glaciation (probably Illinoian) than the overlying softer drift of late Wisconsin Age. The material is fine and very much harder and more compact than the drift forming the present surface.

On the attached engineering soils map, in the left margin, general soil profiles for topographic highs and lows in the ground moraine area have been drawn and designated profiles set

#1. The bounded areas on the map, containing number 1, have high and low position soil profiles similar to those sketched.

Soil borings #86-99 are typical of data obtained from ground moraine areas. Detailed engineering information of these borings are supplied in Appendix C. Well logs 5-9 found in Appendix D are similarly indicative of ground moraine areas.

The parent material (C-horizon) is most often a loam or clay loam (ISHC classification) and most often is found at an average depth range of 24 in. to 50 in. (60-125 cm) as indicated by profile set #1. The steeper the soil slopes, the shallower the top of the C-horizon. For some of the steeper slopes (25-50 percent), the C-horizon may be found at a depth of 14 inches (36 cm). The top of the B-horizon is usually found between an average depth range of 6 in. to 18 in. (15-46 cm) and may be either a loam, clay loam, clay or silty clay. B-horizons in the topographic lows are generally more clayey and thicker than B-horizons in the higher positions. A-horizon material is either a silt loam, silty clay loam, silty clay or clay with average thickness ranges from about 6 in. to 18 in. (15-46 cm).

Quantitative engineering soils data and data on engineering soil problems and uses in the particular ground moraine area are provided in Appendices A and B. To obtain information on soils in gently undulating till plains look up the Miami soils (in highest areas), Crosby soils (between highs and lows), Brookston soils (low areas) and the Kokomo soils (in depressions and drainage ways). For information on the properties of steeply

sloping soils (25-50 percent) between drainage ways and uplands, look up Hennepin soils.

2. Kames and Kame Moraines - Stratified Sand and Gravel Texture (High of soil profile set #3 on map)

In general, kames in Marion County are relatively small both in area and height. Kames and linear ridges of stratified drift in two localities are of sufficient size for commercial exploitation (3). The first area (in sections 18 & 19, T.14N., R.3E., and section 24, T.14N., R.2E.) covers a tract of kames that contain sand and gravel of commercial quality. The second area contains a linear ridge of stratified drift (section 21 & 28, T.15N., R.5E.). There are also some small isolated kames that stand on the till uplands (sections 25 & 26, T.15N., R.3E.; and section 24, T.15N., R.4E.) or on tracts of outwash (section 33, T.15N., R.2E.; and sections 11, 12 & 14, T.14N., R.3E.).

Three kame complexes near Glenns Valley (sections 10, 15, 16, 21 and 22, T.14N., R.3E.) contain commercial deposits of sand and gravel, as is shown by the active pit in SE$\frac{1}{4}$ section 21 and the two abandoned pits in sections 10 and 15. The kame in sections 13 and 14, however, is composed almost entirely of sand. The average grainsize increases slightly in the sediments of an outwash channel phase in sections 17 and 20, T.14N., R.3E. Sand and gravelly sand are exposed in an abandoned pit (section 17) (11).

Fluvial Deposited Materials

The fluvial drift in Marion County include:

Recent flood plains along streams,
stream terraces and
outwash plains

1. Alluvial Plains - Stratified Silts, Fine Sands and Clay Texture (soil profile set #2 on map)

The great bulk of the fluvial drifts are sandy silts, silts and clays that have been deposited upon the flood plains of the many stream valleys in the county. The veneer of postglacial alluvium on the flood plains commonly ranges from a fraction of a foot to twenty feet (0-7 meters) in thickness.

Soils associated with recent alluvium deposits are Genesee, Eel and Shoals. The texture of these soils is controlled by the velocity of water and its transporting power relative to sedimentation.

The Genesee soils tend to form natural levees along the banks. Because of their higher topographic position and slightly more granular texture they drain somewhat faster than the lower Shoals soils adjacent to the valley walls.

Parent material, at a depth of 30 in. to 60 in. (76-152 cm), is usually stratified loams and sandy loams or loams and clay loams. B-horizon materials may be silt loam, silty clay loam, clay loams or loam. Top of the B-horizon is between 7 in. and 20 in. (17-50 cm) . A-horizon materials are usually silt loams or clay loams.

Engineering data for the alluvial soils are found in Appendices A and B. For information on topographic highs in the flood plain, see the Genesee soil, and for low level soils, see Eel and Shoals soils.

Soil borings #138 and #139, Appendex C, are examples of post glacial alluvium deposits. Well log #21, Appendix D, is likewise descriptive of Marion County alluvium.

2. Terraces and Outwash Plains - Stratified Sand and Gravel Texture (Soil Profile Set #3 on Map)

Terraces occur with surfaces some ten to twenty feet (3-7 meters) above the flood plain along the West Fork of the White River through much of Marion County.

Sieve analyses of typical samples from active White River sand and gravel pits showed that the materials being mined were composed of about 50 to 70 percent of particles less than four mesh (0.19 in. or 4.8 mm) in size; that is, these materials were 30 to 50 percent gravel. Such a range of values is only an indication of the gradation of the White River valley outwash material currently being exploited. There is great variability in the gradation of the outwash sediments in Marion County that can be mined at a profit. Noticeable changes in gradation take place along the White River valley from coarser material in the northern part of the county to finer in the southern part. In 1949, most operators of sizing plants in Marion County reported a 60:40 sand-gravel ratio, but there may be a 70:30 ratio in pits in the southern part of the county (11).

Currently mining operations are taking place throughout the entire White River valley.

The stratified sand and gravel parent materials are generally found at depths of between 30 in. and 60 in. (76-152 cm).

The B-horizons usually are gravelly clays at the bottom overlain by mainly clays and clay loams. Depth to the top of the B-horizon is 5 in. to 18 in. (12-46 cm). The A-horizons may be either silt loams, silty clay loam, silty clay or clay.

Where there is a 20 in. to 40 in. (50-102 cm) loess cover, the topographic highs are Ockley soils. Where the loess cover is lacking, the high soils are Fox. In the low areas of the loess areas, the low soils are Sleeth and in the lows of non-loess areas, the soils are Westland. See Appendices A and B, for engineering properties of these soils.

3. Terraces and Outwash Plains - Stratified Sand, Silt and Clay Texture (Soil Profile Set #4 on Map)

A minor proportion of the terrace and outwash plain areas have essentially only sand as the granular material along with significant quantities of silt and clay.

Parent materials in these sand and fines outwash areas are at a depth of 30 in. to 60 in. (76-152 cm). Under the Unified Soil Classification System the materials classify as silty sands (SM), clayey sands (SC) and silts (ML). Pedologically the soils are classified as stratified sands, sandy loams, silt loams, loams and clay loams. The B-horizon is found at a depth ranging between 10 in. and 60 in. (25-152 cm) and is usually clay or silty clay, but the lower part of the

B-horizon of higher topographic position may be a sandy clay or sandy loam. The surface soils of the higher positions are usually clay loam or loams, while the surface soils of the lower positions are usually silty clay loams and silt loams.

For engineering properties of soils in the high and low positions, respectively, see the table data of Martinsville and Whitaker soils in Appendix A and for engineering uses and soil problems see Appendix B.

Eolian Drift

Eolian (or windblown) deposits are also present in Marion County. In sections 21 and 28, T.15N., R.5E. sand ridges are evident. Adjacent to these sand ridges are usually found silt soils. The Princeton soil series is typical of this material. These soils are principally silty and sands having eolian origins. For engineering purposes these soils may be considered as a deep, uniform deposit of brown-yellow windblown sands and silts (2).

For engineering properties, problems and uses of these soils look under Princeton soils in Appendices A and B.

For profile information on eolian landforms, well logs #19 and #20 (Appendix D) are included.

Cumulose Drift

Only two substantial deposits of muck and peat were found in Marion County. "A large bog, known as Bacon Swamp is in northern Indianapolis in section 6 and 7, T.16N., R.4E., and a very small bog is in section 22, T.14N., R.3E. Peat was mined in Bacon Swamp in 1956. The smallest bog has too limited a volume for commercial exploitation". Subsurface exploration is important in these cumulose drift areas.

"Assessment of the peat reserves in Bacon Swamp was made by Professor D. G. Frey of the Zoology Department, Indiana University. A conservative estimate of the amount of recoverable peat, based on Frey's sounding data and probe samples, would be about 800,000 cubic yards. The peat, on the average, is about 3.5 yards thick in the bog area south of 56th Street, and it may also be that thick in the the area north of 56th Street". (11) Some of these areas, presently, may be urbanized.

Airphoto interpretation techniques indicate numerous, widely scattered, small, dark gray to black basins or relatively low topographic areas - an indication of highly organic top soil area. The areas probably are highly organic top soil areas or muck areas and have a slightly deeper depth of organic soils than the swale areas of the till plains.

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APPENDIX A

—*Estimated soil propert*

[An asterisk in the first column of this table indicates that at least one mapping unit in the series is made up of two or more kinds of s
fully the instructions for referring to other series. The s

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Brookston: Br	[1] 0-1	0-18	Silt loam	ML or CL	A-4 or A-6
		18-50	Clay loam	CL	A-6
		50-60	Loam	ML or CL	A-4
Bs	[1] 0-1	0-36	Silty clay loam	OL or CL	A-7
		36-50	Clay loam	CL	A-6
		50-60	Loam	ML or CL	A-4
*Crosby: CrA, CsB2 For Miami part of CsB2, see Miami series.	1-3	0-17	Silt loam	ML or CL	A-4 or A-6
		17-33	Silty clay loam and clay loam	CL or CH	A-7
		33-60	Loam	CL or SC	A-4
Eel:[2] Ee	3-6	0-30	Silt loam	ML or CL	A-4
		30-42	Loam, silt loam, and sandy loam.	ML or CL	A-4
Fincastle: FcA	1-3	0-9	Silt loam	ML or CL	A-4 or A-6
		9-29	Silty clay loam	CH	A-7
		29-42	Clay loam	CL	A-6
		42-68	Loam	CL or SC	A-4
Fox: FoA, FoB2, FoC2	>6	0-14	Loam	ML	A-4
		14-31	Clay loam and gravelly clay loam	SC or CL	A-6
		31-60	Sand and gravel	SW-SM	A-1
FxC3	>6	0-24	Clay loam	SC or CL	A-6
		24-60	Sand and gravel	SW-SM	A-1
Genesee: Gn	>6	0-21	Silt loam	ML	A-4
		21-32	Loam	CL or SC	A-6
		32-60	Sandy loam	SM	A-2 or A-4
Genesee, sandy variant: Gs	>6	0-25	Sandy loam	SM	A-2 or A-4
		25-60	Medium sand	SM or SW-SM	A-1
Hennepin: HeF	>6	0-14	Loam	CL or ML	A-4
		14-60	Loam	CL or SC	A-4
Mahalasville, clayey subsoil variant: Mc.	[1] 0-1	0-15	Silty clay loam	OH or CH	A-7
		15-52	Silty clay	CH	A-7
		52-66	Silty clay loam	CH	A-7
		66-72	Silt loam	ML	A-4
Martinsville: MeA, McB2	>6	0-13	Loam	CL	A-4
		13-53	Clay loam, sandy clay loam, and sandy loam.	CL or SC	A-4
		53-60	Stratified silts, loam, sandy loam, and sand	ML or SM	A-2 or A-4
Miami: MmB2, MmC2, MmD2, MmE2	>6	0-8	Silt loam	ML or CL	A-4 or A-6
		8-31	Clay loam and silty clay loam	CL or CH	A-6 or A-7
		31-60	Loam	CL or SC	A-4
MsB3, MsC3, MsD3	>6	0-24	Clay loam	CL or CH	A-6 or A-7
		24-60	Loam	CL or SC	A-4

See footnotes at end of table.

SOIL LEGEND

Each soil symbol consists of 2 or 3 letters: for example Br, CrA, or FcA. If slope is given in the soil name, the third letter, A, B, C, D, E, or F indicates the class of slope. Symbols without a slope letter are those of nearly level soils. A final number 2 or 3 in the symbol indicates that the soil is eroded or severely eroded respectively.

SYMBOL	NAME
Br	Brookston silt loam, overwash
Bs	Brookston silty clay loam
CrA	Crosby silt loam, 0 to 3 percent slopes
CsB2	Crosby-Miami silt looms, 2 to 6 percent slopes, eroded
FcA	Fincastle silt loam, 0 to 3 percent slopes
FoA	Fox loam, 0 to 2 percent slopes
FoB2	Fox loam, 2 to 6 percent slopes, eroded
FoC2	Fox loam, 6 to 12 percent slopes, eroded
FxC3	Fox clay loam, 6 to 12 percent slopes, severely eroded
Gn	Genesee silt loam
Gs	Genesee sandy loam, sandy variant
HeF	Hennepin loam, 25 to 50 percent slopes

significant to engineering

The different soils in such mapping units mav have different properties and limitations, and for this reason it is necessary to follow car
> means more than; the sign < means less than]

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Frost-heave potential	Shrink-swell potential
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					
			Inches per hour	*Inches per inch of soil*	*pH*		
90–100	90–100	75–85	0. 63–2. 00	0. 22–0. 24	6. 6–7. 3	Moderate to high	Low.
95–100	85–95	70–90	0. 06–0. 20	0. 15–0. 19	6. 6–7. 3	Moderate	Moderate.
90–100	75–90	60–75	0. 20–0. 63	0. 10–0. 19	[3] 7. 4–8. 4	Moderate	Low.
100	90–100	85–95	0. 20–0. 63	0. 21–0. 23	6. 6–7. 3	Moderate	Moderate.
95–100	85–95	70–90	0. 06–0. 20	0. 15–0. 19	6. 6–7. 3	Moderate	Moderate.
90–100	75–90	60–75	0. 20–0. 63	0. 10–0. 19	[3] 7. 4–8. 4	Moderate	Low.
95–100	90–100	75–90	0. 63–2. 00	0. 22–0. 24	5. 1–7. 3	Moderate to high	Low.
95–100	85–95	65–85	0. 06–0. 20	0. 18–0. 20	6. 0–6. 5	Moderate	Moderate.
85–95	70–85	35–65	0. 20–0. 63	0. 05–0. 10	[3] 7. 4–8. 4	Moderate	Low.
100	85–95	60–75	0. 63–2. 00	0. 18–0. 22	5.6–7.3	Low.	Moderate.
100	70–90	50–75	0. 63–2. 00	0. 14–0. 18	5.6–7.3	Low to moderate.	Moderate.
95–100	90–100	75–95	0. 63–2. 00	0. 22–0. 24	6. 1–6. 5	Moderate to high	Low.
100	90–100	85–100	0. 06–0. 20	0. 18–0. 20	5. 1–5. 5	Moderate	Moderate.
95–100	85–100	65–85	0. 06–0. 20	0. 15–0. 19	6. 6–7. 3	Moderate	Moderate.
85–95	70–90	35–70	0. 20–0. 63	0. 05–0. 10	[3] 7. 4–8. 4	Moderate	Low.
85–95	85–100	50–75	0. 63–2. 00	0. 20–0. 22	6. 1–6. 5	Moderate	Low.
90–100	75–90	35–70	0. 63–2. 00	0. 19–0. 21	5. 6–7. 3	Moderate	Moderate.
50–70	20–45	5–15	>20. 00	<0. 08	[3] 7. 4–8. 4	Low	Low.
90–100	75–90	35–70	0. 63–2. 00	0. 19–0. 21	5. 6–7. 3	Moderate	Moderate.
50–70	20–45	5–15	>20. 00	<0. 08	[3] 7. 4–8. 4	Low	Low.
95–100	90–100	75–90	0. 63–2. 00	0. 22–0. 24	7. 3–7. 8	Moderate to high	Low.
90–100	75–100	45–65	0. 63–2. 00	0. 17–0. 19	7. 3–7. 8	Moderate	Low.
90–100	70–100	25–45	2. 00–6. 30	0. 11–0. 13	[3] 7. 4–8. 4	Moderate	Low.
90–100	70–100	25–45	2. 00–6. 30	0. 13–0. 15	6. 6–7. 3	Moderate	Low.
85–100	70–90	5–10	6. 30–20. 00	<0. 08	7. 4–7. 8	Low	Low .
85–95	70–85	50–65	0. 63–2. 00	0. 20–0. 22	6. 6–7. 3	Moderate	Low.
85–95	70–85	35–65	0. 63–2. 00	0. 05–0. 19	[3] 7. 4–8. 4	Moderate	Low.
100	95–100	95–100	0. 20–0. 63	0. 21–0. 23	6. 5–7. 3	Moderate	Moderate.
100	95–100	95–100	0. 06–0. 20	0. 11–0. 13	6. 5–7. 3	Moderate	Moderate.
100	95–100	95–100	0. 20–0. 63	0. 18–0. 20	7. 4–7. 8	Moderate	Moderate.
100	95–100	90–100	0. 20–0. 63	0. 20–0. 22	[3] 7. 4–8. 4	Moderate to high	Low.
85–100	80–95	50–75	0. 63–2. 00	0. 20–0. 22	6. 6–7. 3	Moderate	Low.
90–100	70–90	40–75	0. 63–2. 00	0. 15–0. 19	5. 1–6. 5	Moderate	Moderate.
85–100	70–90	30–70	0. 63–2. 00	0. 17–0. 20	[3] 7. 4–8. 4	Moderate	Low.
95–100	90–100	75–90	0. 63–2. 00	0. 22–0. 24	6. 6–7. 3	Moderate to high	Low.
95–100	85–95	65–85	0. 63–2. 00	0. 15–0. 20	5. 1–6. 0	Moderate	Moderate.
85–95	70–85	35–65	0. 63–2. 00	0. 05–0. 19	[3] 7. 4–8. 4	Moderate	Low.
95–100	85–95	65–85	0. 63–2. 00	0. 15–0. 19	5. 1–6. 0	Moderate	Moderate.
85–95	70–85	35–65	0. 63–2. 00	0. 05–0. 19	[3] 7. 4–8. 4	Moderate	Low.

Mc	Mahalasville silty clay loam, clayey subsoil variant
MeA	Martinsville loam, 0 to 2 percent slopes
MeB2	Martinsville loam, 2 to 6 percent slopes, eroded
MmB2	Miami silt loam, 2 to 6 percent slopes, eroded
MmC2	Miami silt loam, 6 to 12 percent slopes, eroded
MmD2	Miami silt loam, 12 to 18 percent slopes, eroded
MmE2	Miami silt loam, 18 to 25 percent slopes, eroded
MsB3	Miami clay loam, 2 to 6 percent slopes, severely eroded
MsC3	Miami clay loam, 6 to 12 percent slopes, severely eroded
MsD3	Miami clay loam, 12 to 18 percent slopes, severely eroded
OcA	Ockley silt loam, 0 to 2 percent slopes
OcB2	Ockley silt loam, 2 to 6 percent slopes, eroded
OsA	Ockley silt loam, loamy substratum, 0 to 2 percent slopes
OsB2	Ockley silt loam, loamy substratum, 2 to 6 percent slopes, eroded
Ra	Ragsdale silty clay loam
Rn	Rensselaer clay loam
RuB2	Russell silt loam, 2 to 6 percent slopes, eroded
RuC2	Russell silt loam, 6 to 12 percent slopes, eroded
Sh	Shoals silt loam
Wh	Whitaker silt loam
XeA	Xenia silt loam, 0 to 2 percent slopes
XeB2	Xenia silt loam, 2 to 6 percent slopes, eroded

Estimated soil propertie

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Ockley:					
OcA, OcB2	>6	0–14	Silt loam	ML or CL	A–4 or A–6
		14–24	Silty clay loam	CL	A–6
		24–48	Clay loam and sandy clay loam	CL or SC	A–6
		48–60	Sand and gravel	SW–SM	A–1
OsA, OsB2	>6	0–8	Silt loam	ML or CL	A–4 or A–6
		8–48	Clay loam	CL	A–6
		48–53	Sand and gravel	SW–SM	A–1
		53–60	Loam	CL or SC	A–4
Ragsdale: Ra	[1] 0–1	0–42	Silty clay loam	OL or CH	A–7
		42–60	Silt loam and loam	ML	A–4
Rensselaer: Rn	[1] 0–1	0–16	Clay loam	CL or CH	A–7
		16–47	Clay loam and sandy clay loam	CH	A–7
		47–72	Loamy sand, sandy loam, and silt loam	SC	A–2 or A–4
Russell: RuB2, RuC2	>6	0–10	Silt loam	ML or CL	A–4 or A–6
		10–25	Silty clay loam	CH	A–7
		25–59	Clay loam	CL or CH	A–6 or A–7
		59–64	Loam	CL or SC	A–4
Shoals: Sh	1–3	0–34	Silt loam	ML	A–4
		34–60	Stratified loam, sandy loam, and sandy clay loam.	SC or SM	A–2 or A–4
Whitaker: Wh	1–3	0–12	Silt loam	ML or CL	A–4 or A–6
		12–30	Clay loam	CL	A–6
		30–48	Sandy clay loam and sandy loam	SC or CL	A–6
		48–60	Stratified loam, sandy loam, and medium sand.	SC or SM	A–2 or A–4
Xenia: XeA, XeB2	3–6	0–12	Silt loam	ML or CL	A–4 or A–6
		12–30	Silty clay loam	CH	A–7
		30–42	Clay loam	CL or CH	A–6 or A–7
		42–60	Loam	CL or SC	A–4

[1] Ponded.

significant to engineering—

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Frost-heave potential	Shrink-swell potential
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					
			Inches per hour	*Inches per inch of soil*	*pH*		
95-100	90-100	75-90	0. 63-2. 00	0. 22-0. 24	6. 6-7. 3	Moderate to high	Low.
90-100	80-95	70-90	0. 63-2. 00	0. 18-0. 20	5. 6-6. 5	Moderate	Moderate.
80-100	65-90	40-75	0. 63-2. 00	0. 19-0. 21	5. 6-6. 5	Moderate	Moderate.
50-70	20-45	5-15	>20. 00	<0. 08	[3] 7. 4-8. 4	Low	Low.
100	90-100	75-90	0. 63-2. 00	0. 22-0. 24	6. 6-7. 3	Moderate to high	Low.
90-100	80-95	70-90	0. 63-2. 00	0. 19-0. 21	5. 6-6. 5	Moderate	Moderate.
50-70	20-45	5-15	>20. 00	<0. 08	[3] 7. 4-8. 4	Low	Low.
85-95	70-85	45-65	0. 63-2. 00	0. 05-0. 19	[3] 7. 4-8. 4	Moderate	Low.
100	90-100	95-100	0. 06-0. 20	0. 21-0. 23	6. 1-7. 3	Moderate to high	Moderate.
95-100	90-100	85-95	0. 20-0. 63	0. 17-0. 22	[3] 7. 4-8. 4	High	Low.
95-100	75-95	60-80	0. 20-0. 63	0. 17-0. 19	6. 6-7. 3	Moderate	Moderate.
90-100	70-85	50-75	0. 06-0. 20	0. 19-0. 21	6. 6-7. 3	Moderate	Moderate.
90-100	70-95	10-50	0. 63-2. 00	0. 08-0. 22	[3] 7. 4-8. 4	Moderate	Low.
95-100	90-100	85-95	0. 63-2. 00	0. 22-0. 24	5. 1-7. 3	Moderate to high	Low.
95-100	90-100	85-95	0. 63-2. 00	0. 18-0. 20	4. 6-5. 0	Moderate	Moderate.
95-100	85-95	65-85	0. 63-2. 00	0. 15-0. 19	5. 1-7. 3	Moderate	Moderate.
85-95	70-85	35-65	0. 63-2. 00	0. 05-0. 19	[3] 7. 4-8. 4	Moderate	Low.
95-100	90-100	75-90	0. 63-2. 00	0. 22-0. 24	6. 6-7. 3	Moderate to high	Low.
90-100	75-100	10-50	0. 63-2. 00	0. 11-0. 19	6. 6-7. 3	Moderate	Low.
95-100	90-100	65-90	0. 63-2. 00	0. 22-0. 24	5. 1-7. 3	Moderate to high	Low.
95-100	85-95	65-85	0. 63-2. 00	0. 15-0. 19	5. 1-6. 5	Moderate	Moderate.
90-100	70-90	45-55	0. 63-2. 00	0. 14-0. 18	6. 1-7. 3	Moderate	Low.
95-100	70-90	10-50	0. 63-2. 00	0. 07-0. 19	[3] 7. 4-8. 4	Moderate	Low.
95-100	90-100	85-95	0. 63-2. 00	0. 22-0. 24	6. 6-7. 3	Moderate to high	Low.
95-100	90-100	85-95	0. 20-0. 63	0. 18-0. 20	5. 6-7. 3	Moderate	Moderate.
95-100	85-95	65-85	0. 20-0. 63	0. 15-0. 19	6. 6-7. 3	Moderate	Moderate.
85-95	70-85	35-65	0. 63-2. 00	0. 05-0. 19	[3] 7. 4-8. 4	Moderate	Low.

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[3] Calcareous.

APPENDIX B

[An asterisk in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. The different instructions for referring

Soil series and map symbols	Suitability as source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road subgrade material	Highway location	Agricultural drainage	Farms ponds	
						Reservoir areas	Embankments, dikes, and levees
Brookston: Br, Bs.	Good in surface layer. Poor in subsoil: moderately fine texture; seasonal high water table.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability; seasonal high water table.	Seasonal high water table; subject to frost heave.	Seasonal high water table; slow permeability.	Moderate to slow seepage; seasonal high water table.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
*Crosby: CrA, CsB2. For Miami part of CsB2, see Miami series.	Good in surface layer. Fair to poor in subsoil: moderately fine texture; seasonal high water table.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability; seasonal high water table.	Seasonal high water table; subject to frost heave.	Seasonal high water table; slow permeability.	Moderate to slow seepage; seasonal high water table.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
Eel: Ee	Surface layer and sub soil good: subject to flooding.	Generally not suitable	Subsoil and substratum fair to poor: moderate shrink-swell potential; moderate to high frost-heaving potential; fair compaction characteristics; fair stability; medium compressibility.	high frost heave; subject to flooding.	Subject to flooding.	Moderate to slow seepage rate	Subsoil and substratum: fair compaction characteristics; low permeability when compacted; fair to good resistance to piping; fair stability.
Fincastle: FcA.	Good in surface layer. Fair to poor in subsoil: moderately fine texture; seasonal high water table.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability; seasonal high water table.	Seasonal high water table; subject to frost heave.	Seasonal high water table; slow permeability.	Moderate to slow seepage; seasonal high water table.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.

See footnotes at end of table.

engineering properties

soils in such mapping units may have different properties and limitations; and for this reason it is necessary to follow carefully tł
to other series]

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Soil features favorable; generally not needed.	Soil features favorable; generally not needed, but diversions can be used to channel excess water from higher soils.	Seasonal high water table; subject to ponding; fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Severe: slow permeability; seasonal high water table.	Severe: very poorly drained; seasonal high water table; subject to ponding.	Severe: very poorly drained; seasonal high water table; subject to ponding.
Soil features favorable.	Soil features favorable.	Seasonal high water table; fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Severe: slow permeability; seasonal high water table.	Moderate: somewhat poorly drained; seasonal high water table.	Moderate: somewhat poorly drained; seasonal high water table; use limited to periods when water table is at a depth of more than 48 inches.
Not needed, except where overflow water concentrates.	Not needed, except to divert runoff from adjoining higher areas.	Subject to flooding; moderate shrink-swell potential; moderate to high frost-heaving potential; fair shear strength.	Severe: subject to flooding	Severe: subject to flooding.	Severe: subject to stream flooding.
Soil features favorable.	Soil features favorable.	Seasonal high water table; fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Severe: slow permeability; seasonal high water table.	Moderate: somewhat poorly drained; seasonal high water table; use limited to periods when water table is at a depth of more than 48 inches.	Moderate: somewhat poorly drained; seasonal high water table; use limited to periods when water table is at a depth of more than 48 inches.

—Interpretations of

Soil series and map symbols	Suitability as source of—			Soil features affecting—			
						Farms ponds	
	Topsoil	Sand and gravel	Road subgrade material	Highway location	Agricultural drainage	Reservoir areas	Embankments, dikes, and levees
Fox: FoA, FoB2, FoC2.	Fair to good in surface layer. Poor to fair in subsoil: moderately fine to coarse texture.	Good: about 3 feet of overburden on well-graded mixture of sand and gravel.	Poor in subsoil: fair shear strength; good to fair compaction characteristics; medium compressibility; moderate shrink-swell potential; subject to frost heave; fair stability. Very good in substratum: good to fair shear strength; fair to good compaction characteristics; slight compressibility; low shrink-swell potential; low susceptibility to frost heave; fair to poor stability.	Loose sand and gravel easily excavated but sometimes hinders hauling; cuts and fills often needed; difficult to vegetate exposed gravel in road cuts; subject to frost heave.	Natural drainage adequate; not needed.	Rapid seepage in substratum.	Fair stability in subsoil: good to fair compaction characteristics; low permeability when compacted; medium compressibility; good resistance to piping; moderate shrink-swell potential; fair shear strength. Fair to poor stability in substratum: fair to good compaction characteristics; high to moderate permeability when compacted; slight compressibility; fair to good resistance to piping; low shrink-swell potential; good to fair shear strength.
FxC3	Poor to fair in surface layer. Poor to fair in subsoil: moderately fine to coarse texture.	Good: about 3 feet of overburden on well-graded mixture of sand and gravel.	Poor in subsoil: fair shear strength; good to fair compaction characteristics; medium compressibility; moderate shrink-swell potential; subject to frost heave; fair stability. Very good in substratum: good to fair shear strength; fair to good compaction characteristics; slight compressibility; low shrink-swell potential; low susceptibility to frost heave; fair to poor stability.	Loose sand and gravel easily excavated but sometimes hinders hauling; cuts and fills often needed; difficult to vegetate exposed gravel in road cuts; subject to frost heave in subsoil.	Natural drainage adequate; not needed.	Rapid seepage in substratum.	Fair stability in subsoil: good to fair compaction characteristics; low permeability when compacted; medium compressibility; good resistance to piping; moderate shrink-swell potential; fair shear strength Fair to poor stability in substratum: fair to good compaction characteristics; high to moderate permeability when compacted; slight compressibility; fair to good resistance to piping; low shrink-swell potential; good to fair shear strength.

See footnotes at end of table.

engineering properties—

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Difficult to vegetate; erosion hazard during construction.	Difficult to vegetate; erosion hazard during construction.	Good to fair shear strength; moderate to low shrink-swell potential; medium compressibility in subsoil; slight compressibility in substratum.	Slight: moderate permeability; possible contamination of ground water.	Severe: porous sand and gravel at depths of 31 to 60 inches; very rapid permeability in sand and gravel.	Severe: porous sand and gravel at depths of 31 to 60 inches; hazard of free leachate flow to ground water.
Difficult to vegetate; erosion hazard during construction.	Difficult to vegetate; erosion hazard during construction.	Good to fair shear strength; moderate to low shrink-swell potential; medium compressibility in subsoil; slight compressibility in substratum.	Slight: moderate permeability; possible contamination of ground water.	Severe: porous sand and gravel at depths of 31 to 60 inches; very rapid permeability in sand and gravel.	Severe: porous sand and gravel at depths of 31 to 60 inches; hazard of free leachate flow to ground water.

—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Soil features affecting—			
						Farms ponds	
	Topsoil	Sand and gravel	Road subgrade material	Highway location	Agricultural drainage	Reservoir areas	Embankments, dikes, and levees
Genesee: Gn.	Good in surface layer: subject to stream flooding.	Poor to unsuitable: location of sand and gravel spotty; deep overburden; dipper equipment necessary.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; low shrink-swell potential; subject to frost heave; fair stability.	Subject to flooding and frost heave.	Natural drainage adequate; subject to flooding; not needed.	Moderate to slow seepage; subject to flooding.	Fair stability in subsoil and substratum: fair to poor compaction characteristics; moderate to low permeability when compacted; medium to high compressibility; fair resistance to piping; low shrink-swell potential; fair to poor shear strength.
Genesee sandy variant: Gs.	Fair in surface layer. Fair to poor in subsoil: coarse texture; subject to flooding.	Poor to unsuitable; location of sand and gravel spotty; deep overburden; dipper equipment necessary.	Fair to good in subsoil and substratum: fair shear strength; fair compaction characteristics; slight compressibility; low shrink-swell potential; subject to frost heave; fair stability.	Subject to flooding and frost heave.	Natural drainage adequate; subject to flooding; not needed.	Rapid seepage in substratum; subject to flooding.	Fair stability in subsoil and substratum: fair compaction characteristics; high to moderate permeability when compacted; slight compressibility; fair to good resistance to piping; low shrink-swell potential; fair shear strength.
Hennepin: HeF.	Fair in surface layer: thin; steep slopes. Fair to poor in subsoil.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; low shrink-swell potential; subject to frost heave; fair stability.	Cuts and fills needed; difficult to vegetate road cuts; subject to frost heave.	Natural drainage adequate; not needed.	Moderate to slow seepage.	Fair stability in subsoil and substratum: fair to poor compaction characteristics; moderate to low permeability when compacted; medium to high compressibility; fair resistance to piping; low shrink-swell potential; fair to poor shear strength.
Mahalasville, clayey subsoil variant: Mc.	Fair to good in surface layer: moderately fine texture. Poor in subsoil: fine texture; seasonal high water table.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate shrink-swell potential; subject to frost heave; fair to poor stability; seasonal high water table.	Seasonal high water table; subject to frost heave.	Seasonal high water table; slow permeability; stratified silt and clay below depth of 36 inches.	Moderate to slow seepage; seasonal high water table.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate shrink-swell potential; fair to poor shear strength.

See footnotes at end of table.

engineering properties—

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [3]
Soil features favorable; generally not needed.	Soil features favorable; not needed because of topography.	Subject to flooding; fair to poor shear strength; low shrink-swell potential; medium to high compressibility.	Severe: subject to flooding; moderate permeability.	Severe: subject to flooding.	Severe: subject to flooding.
Difficult to vegetate; generally not needed.	Not needed	Subject to flooding; fair to poor shear strength; low shrink-swell potential; medium to high compressibility.	Severe: subject to flooding; moderately rapid permeability.	Severe: subject to flooding.	Severe: subject to flooding.
Difficult to vegetate; erosion hazard during construction.	Not needed	Fair to poor shear strength; low shrink-swell potential; medium to high compressibility.	Severe: slopes too steep; moderate permeability.	Severe: steep slopes severely hinder development of site.	Severe: steep slopes severely hinder development of site.
Soil features favorable; generally not needed.	Soil features favorable; generally not needed, but diversions can be used to channel excess water from higher soils.	Seasonal high water table; subject to ponding; fair to poor shear strength; moderate shrink-swell potential; medium to high compressibility.	Severe: slow permeability; seasonal high water table.	Severe: very poorly drained; seasonal high water table.	Severe: very poorly drained; seasonal high water table; clayey material hinders trafficability and is subject to cracking or drying.

—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road subgrade material	Highway location	Agricultural drainage	Farms ponds	
						Reservoir areas	Embankments, dikes, and levees
artinsville: MeA, MeB2.	Good to fair in surface layer. Fair to poor in subsoil: moderately fine texture.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair stability.	Cuts and fills generally needed; subject to frost heave.	Natural drainage adequate; not needed.	Moderate seepage.	Fair stability in subsoil and substratum: fair to poor compaction characteristics; moderate to low permeability when compacted; medium to high compressibility; fair resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
iami: MmB2, MmC2, MmD2, MmE2.	Fair to poor in surface layer and in subsoil: moderately fine texture.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability.	Cuts and fills needed; subject to frost heave.	Natural drainage adequate; not needed.	Moderate to slow seepage.	Fair to poor stability in substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
MsB3, MsC3, MsD3.	Poor in surface layer and subsoil: moderately fine texture.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability.	Cuts and fills needed; subject to frost heave.	Natural drainage adequate; not needed.	Moderate to slow seepage.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.

See footnotes at end of table.

engineering properties—

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Slight	Severe: underlying material too sandy to hold water.	Severe: porous sand and gravel at depth of 48 to 68 inches; hazard of free leachate flow to ground water.
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Moderate: moderate permeability.	Moderate where slopes are 2 to 6 percent: moderate permeability. Severe where slopes are 6 to 25 percent: slope severely hinders development of site.	Slight where slopes are 2 to 12 percent. Moderate where slopes are 12 to 25 percent: slope moderately hinders development of site.
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Moderate: moderate permeability.	Moderate where slopes are 2 to 6 percent: moderate permeability. Severe where slopes are 6 to 18 percent: slope severely hinders development of site.	Slight where slopes are 2 to 12 percent. Moderate where slopes are 12 to 18 percent: slope hinders development of site.

—Interpretations of

Soil series and map symbols	Suitability as source of—			Soil features affecting—			
						Farms ponds	
	Topsoil	Sand and gravel	Road subgrade material	Highway location	Agricultural drainage	Reservoir areas	Embankments, dikes, and levees
Ockley: OcA, OcB2.	Good in surface layer. Fair in subsoil: moderately fine to coarse texture.	Good: at least 3 feet of overburden on well-graded mixture of sand and gravel.	Poor in subsoil: fair shear strength; good to fair compaction characteristics; medium compressibility; moderate shrink-swell potential; subject to frost heave; fair stability. Very good in substratum: good to fair shear strength; fair to good compaction characteristics; slight compressibility; low shrink-swell potential; low susceptibility to frost heave; fair to poor stability.	Loose sand and gravel easy to excavate but sometimes hinders hauling; cuts and fills often needed; difficult to vegetate exposed gravel in road cuts; subsoil subject to frost heave.	Natural drainage adequate; not needed.	Rapid seepage in substratum.	Fair stability in subsoil: good to fair compaction characteristics; low permeability when compacted; medium compressibility; good resistance to piping; moderate shrink-swell potential; fair shear strength. Fair to poor stability in substratum: fair to good compaction characteristics; high to moderate permeability when compacted; slight compressibility; fair to good resistance to piping; low shrink-swell potential; good to fair shear strength.
OsA, OsB2.	Good in surface layer. Fair in subsoil; moderately fine to coarse texture.	Not suitable.	Poor in subsoil: fair shear strength; good to fair compaction characteristics; medium compressibility; moderate shrink-swell potential; subject to frost heave; fair stability. Very good in substratum: good to fair shear strength; fair to good compaction characteristics; slight compressibility; low shrink-swell potential; low susceptibility to frost heave; fair to poor stability.	Cuts and fills needed; subject to frost heave.	Natural drainage adequate; not needed.	Moderate to slow seepage.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
Ragsdale: Ra.	Good in surface layer. Fair to poor in subsoil; moderately fine texture; seasonal high water table.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair compaction characteristics; medium compressibility; moderate to low shrink-swell potential; subject to frost heave; fair stability; seasonal high water table.	Seasonal high water table; moderately high susceptibility to frost heave.	Seasonal high water table; slow permeability.	Moderate to slow seepage; seasonal high water table.	Fair stability in subsoil and substratum: fair compaction characteristics; moderate to low permeability when compacted; medium compressibility; fair resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.

See footnotes at end of table.

engineering properties—

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Soil features favorable.	Soil features favorable.	Good to fair shear strength; moderate to low shrink-swell potential; medium compressibility in subsoil; slight compressibility in substratum.	Slight: moderate permeability; possible contamination of ground water.	Severe: porous sand and gravel at depth of 48 to 68 inches; very rapid permeability in sand and gravel.	Severe: porous sand and gravel at depth of 48 to 68 inches; hazard of leachate flow to ground water.
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Moderate: moderate permeability.	Moderate: lateral seepage through strata of sand and gravel.	Sight.
Soil features favorable; generally not needed.	Soil features favorable; generally not needed, but diversions can be used to channel excess water from higher soils.	Seasonal high water table; subject to ponding; fair to poor shear strength; moderate to low shrink-swell potential; medium compressibility; moderate to high susceptibility to frost heave.	Severe: slow permeability; seasonal high water table.	Severe: very poorly drained; seasonal high water table.	Severe: very poorly drained; seasonal high water table; subject to ponding; silty clay loam and silt loam materials hinder trafficability.

—Interpretations of

Soil series and map symbols	Suitability as source of—			Soil features affecting—			
						Farms ponds	
	Topsoil	Sand and gravel	Road subgrade material	Highway location	Agricultural drainage	Reservoir areas	Embankments, dikes, and levees
Rensselaer: Rn.	Fair to good in surface layer: moderately fine texture. Poor in subsoil: moderately fine texture; seasonal high water table.	Not suitable.	Poor in subsoil: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate shrink-swell potential; subject to frost heave; fair stability; seasonal high water table. Fair to poor in substratum: fair to poor shear strength; poor compaction characteristics; medium compressibility; low shrink-swell potential; subject to frost heave; poor stability.	Seasonal high water table; subject to frost heave.	Seasonal high water table; slow permeability; sand and gravel substratum.	Moderate to slow seepage; seasonal high water table.	Fair stability in subsoil: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate shrink-swell potential; fair to poor shear strength. Poor stability in substratum: poor compaction characteristics; moderate permeability when compacted; medium compressibility; poor resistance to piping; low shrink-swell potential; fair to poor shear strength.
Russell: RuB2, RuC2.	Fair to good in surface layer. Fair to poor in subsoil: somewhat moderately fine texture.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability.	Cuts and fills needed; subject to frost heave.	Natural drainage adequate; not needed.	Moderate to slow seepage.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
Shoals: Sh	Good in surface layer. Good to fair in subsoil: subject to stream flooding; seasonal high water table.	Poor to unsuitable; location of sand and gravel spotty; deep overburden; dipper equipment necessary.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; low shrink-swell potential; subject to frost heave; seasonal high water table.	Subject to flooding and frost heave; seasonal high water table.	Seasonal high water table; moderate permeability; subject to flooding.	Moderate to slow seepage; subject to flooding; seasonal high water table.	Fair stability in subsoil and substratum: fair to poor compaction characteristics; moderate to low permeability when compacted; medium to high compressibility; fair resistance to piping; low shrink-swell potential; fair to poor shear strength.

See footnotes at end of table.

engineering properties—

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Soil features favorable; generally not needed.	Soil features favorable; generally not needed, but diversions can be used to channel excess water from higher soils.	Seasonal high water table; subject to ponding; fair to poor shear strength; moderate shrink-swell potential; medium to high compressibility.	Severe: slow permeability; seasonal high water table.	Severe: very poorly drained; seasonal high water table; subject to ponding.	Severe: very poorly drained; seasonal high water table; subject to ponding
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Moderate: moderate permeability.	Moderate where slopes are 2 to 6 percent: moderate permeability. Severe where slopes are 6 to 12 percent: moderate permeability.	Slight.
Soil features favorable; generally not needed.	Soil features favorable; not needed.	Seasonal high water table; subject to flooding; fair to poor shear strength; low shrink-swell potential; medium to high compressibility.	Severe: seasonal high water table; subject to flooding; moderate permeability.	Severe: subject to flooding.	Severe: subject to flooding; somewhat poorly drained; seasonal high water table.

—*Interpretations o*

Soil series and map symbols	Suitability as source of—			Soil features affecting—			
						Farms ponds	
	Topsoil	Sand and gravel	Road subgrade material	Highway location	Agricultural drainage	Reservoir areas	Embankments, dikes, and levees
Whitaker: Wh	Good in surface layer. Fair to poor in subsoil: moderately fine texture; seasonal high water table.	Not suitable.	Poor in subsoil: fair to poor shear strength; fair to poor compaction characteristics; moderate shrink-swell potential; subject to frost heave; fair stability; seasonal high water table. Fair to poor in substratum: fair to poor shear strength; poor compaction characteristics; medium compressibility; low shrink-swell potential; subject to frost heave; poor stability.	Seasonal high water table.	Seasonal high water table; moderate permeability; stratified silt and sand below depth of 36 inches.	Moderate seepage; seasonal high water table.	Fair stability in subsoil: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate shrink-swell potential; fair to poor shear strength. Poor stability in substratum: poor compaction characteristics; moderate permeability when compacted; medium compressibility; poor resistance to piping; low shrink-swell potential; fair to poor shear strength.
Xenia: XeA, XeB2.	Fair to good in surface layer. Fair to poor in subsoil: moderately fine texture.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability.	Cuts and fills generally needed; subject to frost heave.	Natural drainage adequate; generally not needed.	Moderate to slow seepage.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.

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[1] Not suitable if slope is more than 12 percent.

engineering properties—

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Soil features favorable.	Soil features favorable.	Seasonal high water table; fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Severe: moderate permeability; seasonal high water table.	Severe: stratified material at depth less than 5 feet allows for possible rapid seepage.	Severe: somewhat poorly drained; seasonal high water table; stratified silty and sandy material at depth less than 60 inches; hazard of free leachate flow to ground water.
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Moderate: moderately slow permeability.	Moderate: moderately slow permeability.	Moderate: silty clay loam and clay loam texture moderately affects workability.

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[2] Onsite study of the underlying strata, water tables, and hazards of aquifer pollution and drainage into ground water need to be mad for landfills more than 5 to 6 feet deep.

APPENDIX C

APPENDIX C

I-465 Boring Data in Marion County (Sites 1-71), I-65 (Sites 72-78) and I-70 (Sites 79-139)

The soil test data tabulated below was obtained from consultants' reports prepared for the Indiana State Highway Commission. The location of the site is shown on the attached engineering soils map. Considerable additional data is contained in the consultants reports.

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
1	401+00	42 L	2-4	A-7-6(10)	Clay	0	22	47	31	41	26	15	15
2	418+00	42 L	0-2	A-7-6(13)	Cl./Or.	0	36	30	34	48	24	24	15
3	421+00	42 R	4-6	A-6(4)	Sa.Cl.L.	0	53	18	29	29	15	14	14
4	423+15	42 L	6-8	A-4(2)	Sa.L.	0	59	22	19	17	11	6	14
5	426+00	42 R	1-2	A-6(5)	Sa.Cl.L.	0	61	14	25	35	17	18	18
6	435+00	42 L	1.5-4	A-4(4)	Cl.L.	0	48	29	23	20	13	7	17
7	457+00	42 R	1-2	A-7-6(12)	Clay	0	40	22	38	46	22	24	14
8	466+95	42 R	0-3.5	A-4(6)	Cl.L.	0	39	40	21	19	12	7	14
			3.5-4.5	A-2-4(0)	Sa.L.	0	72	20	8	18	NP	NP	15
9	473+00	42 R	1.0-3.0	A-7-5(14)	Cl./Or.	0	21	44	35	50	31	19	15
			4.0-6.0	A-6(7)	Clay	0	43	27	30	33	18	15	16
10	481+00	42 L	3.0-5.0	A-4(1)	Sa.L.	0	67	17	16	20	NP	NP	18
			5.0-8.0	A-6(4)	Sa.Cl.L.	0	56	20	24	30	17	13	14
11	483+00	42 R	4.0-5.0	A-6(8)	Clay	0	35	32	33	27	15	12	13
12	506+00	31 R	2.5-6.0	A-4(2)	Sa.L.	0	56	25	19	19	11	8	13
13	511+00	42 R	0.5-2.0	A-6(7)	Cl.L.	0	38	33	29	33	19	14	16
			4.0-6.0	A-1-6(0)	Sand	0	80	14	6	NP	NP	NP	NP
14	526+00	42 L	4.5-6.0	A-6(7)	Cl.L.	0	42	29	29	29	14	15	15
			7.0-8.0	A-4(3)	Sa.L.	0	52	31	17	17	12	5	13
15	540+80	42 L	0.0-2.0	A-6(9)	Si.Cl./Or.	0	25	50	25	36	22	14	21

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
16	891+00	42 R	5-6	A-1-b(0)	Sa.&Gr.					NP	NP	NP	--
			22.5-25.0	A-1-b(0)						NP	NP	NP	--
17	895+00	500 R	10.5-12.0	A-1-a(0)	Gr.&Sa.					NP	NP	NP	--
18	901+50	CL	8-9	A-1-a(0)						NP	NP	NP	--
			10-12	A-1-b(0)	Sa.&Gr.					NP	NP	NP	--
19	906-25	42 L	4-6	A-2-6(0)	Sa.L.	0	71	18	11	28	15	13	--
20	911+06	42 L	5-6	A-7-6(18)	Si.Cl.L.	0	20	51	29	50	20	30	--
21	913+38	42 R	4-6	A-6(7)	Cl.	0	40	27	33	34	18	16	13
22	919+00	42 R	2.3-4	A-4(2)	Sa.L.	0	53	29	18	18	11	8	--
23	922+00	42 L	0-1							--	--	--	--
24	925+00	42 R	6-7.5	A-4(4)	Cl.L.	0	43	33	24	20	11	9	11
25	928+00	42 L	2-4	A-6(7)	Cl.	0	34	36	30	25	13	12	14
26	933+90	42 L	2-4	A-7-6(13)	Cl.	0	32	36	32	43	18	25	12
27	945+00	42 L	3-4	A-4(5)	Cl.L.	0	43	35	22	21	11	10	12
28	952+00	42 R	0-2	A-4(5)	Loam	0	40	40	20	26	17	9	17
29	955+00	42 L	0-1.6							--	--	--	--
30	958+00	42 R	2-4	A-6(9)	Cl.L.	0	33	43	24	29	13	16	14
31	964+00	42 R	4.2-6	A-4(8)	Si.Cl.L.	0	27	52	21	19	14	5	14
32	970+20	42 R	4-6	A-6(4)	Cl.L.	0	45	29	26	25	14	11	14
33	973+00	42 L	4.6-6	A-2-4(0)	Sa.L.	0	70	21	9	NP	NP	NP	--
34	985+25	42 L	2-4	A-6(6)	Cl.L.	0	39	37	24	23	11	12	13
35	993+50	42 R	2-4	A-6(13)	Si.Cl.L.	0	22	50	28	38	15	23	14
36	996+00	42 L	11-12.5	A-4(5)	Cl.L.	0	38	32	30	21	12	9	12
37	1001+50	42 L	8.5-9.8	A-4(8)	Si.Cl.L.	0	5	67	28	21	17	4	17
38	1011+00	42 R	4-5	A-6(13)	Clay	0	26	42	32	38	16	22	13
39	1017+00	42 R	0-1.5	A-6(13)	Si.Cl.L.	0	22	52	26	41	17	24	17

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
40	1026+00	42 L	2-4	A-7-6(13)	Cl.L.	0	37	39	24	44	17	27	--
41	1032+00	42 L	5-6	A-2-4(0)	Sa.L.	0	68	18	14	17	NP	NP	14
42	1044+05	42 L	6.3-8	A-6(6)	Cl.L.	0	40	37	23	24	12	12	--
43	1051+35	42 L	0-2	A-4(6)	Cl.L.	0	35	45	20	25	18	7	19
44	1058+00	42 L	6-7.5	A-4(5)	Cl.L.	0	41	34	25	20	11	9	12
45	1060+90	42 R	4-6	A-6(6)	Cl.L.	0	38	35	27	24	11	13	13
46	1068+00	42 L	0-2	A-7-6(20)	Cl.	0	16	44	40	58	19	39	14
47	767+00	42 R	1-7	A-7-6(18)	Clay	0	26	42	32	53	22	31	15
48	782+00	42 R	4-6	A-7-6(15)	Clay	0	31	32	37	47	20	27	16
49	788+00	42 L	1-4	A-7-6(15)	Clay	0	19	45	36	45	19	26	14
50	797+00	42 R	5-13	A-2-4(0)	Sa.Cl.L.	0	69	9	22	21	14	7	13
51	800+75	42 L	0.5-5.0	A-6(11)	Clay	0	37	30	33	40	17	23	14
			10-12	A-4(2)	Sa.L.	0	59	23	18	18	13	5	13
52	806+00	42 L	9.5-12.5	A-4(5)	Loam	0	43	39	18	22	13	9	13
53	818+00	42 L	1-4	A-7-6(14)	Clay	0	45	24	31	50	18	32	18
54	821+00	42 R	1-2	A-7-6(11)	Loam	0	39	43	18	42	19	23	15
55	827+00	42 R	4-6	A-4(2)	Sa.Cl.L.	0	60	19	21	24	14	10	14
56	830+00	42 L	2-4	A-7-6(15)	Clay	0	41	29	30	56	20	36	14
57	833+00	42 R	2-6	A-7-6(14)	Cl.L.	0	31	47	22	45	19	26	14
58	846+00	42 R	1-4	A-6(7)	Cl.L.	0	37	40	23	31	19	12	22
59	855+00	42 L	5-13	A-6(2)	Sa.L.	0	67	26	7	39	21	18	19
60	858+00	42 R	0-4	A-7-6(13)	Clay	0	49	17	34	52	22	30	19
			4-8	A-6(5)	Sa.Cl.L.	0	60	14	26	36	17	19	16
			17-21	A-4(8)	Si.L.	0	22	67	11	18	12	6	13
61	861+00	42 L	15-20	A-4(1)	Sa.L.	0	62	19	19	22	12	10	12
62	875+00	42 R	0.5-8.0	A-6(10)	Cl.L.	0	42	33	25	32	11	21	15

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent				L.L.	P.L.	P.I.	S.L.
						Gravel	Sand	Silt	Clay				
63	899+00	42 R	3-6	A-7-6(14)	Cl.L.	0	23	49	28	43	21	22	17
64	908+00	42 L	1-5	A-6(7)	Clay	0	37	30	33	29	16	13	15
			5-10	A-4(1)	Sa.L.	0	60	27	13	18	13	5	12
			10-15	A-6(3)	Sa.L.	0	60	26	14	25	11	14	18
65	917+00	42 R	1-5	A-7-6(14)	Clay	0	20	48	32	42	18	24	15
			5-9	A-6(10)	Si.Cl.L.	0	24	52	24	36	21	15	17
66	924+00	42 R	3-6	A-6(5)	Cl.L.	0	44	33	23	24	13	11	14
67	930+00	42 R	1.5-3.0	A-6(12)	Clay	0	25	41	34	35	16	19	16
68	939+00	42 L	2-4	A-7-5(10)	Cl.L.	0	46	25	29	51	32	19	16
69	942+00	42 R	3-6	A-6(7)	Loam	0	44	37	19	30	15	15	15
70	945+00	42 L	1-3	A-7-6(19)	Si.C.	0	15	52	33	57	23	34	18
			3-4	A-7-6(15)	Cl.L.	0	24	49	27	44	18	26	14
71	948+00	42 R	1-3	A-6(3)	Sa.	0	64	27	9	34	15	19	16
72	218+72	40 L	1-2.5	A-7-6(19)	Clay	0	21	31	48	55	21	34	18
			3.5-5.0	A-7-6(13)	Clay	0	30	31	39	41	17	24	18
73	223+14	CL	6-7.5	A-4(3)	Sa.L.	0	55	27	18	19	13	6	15
74	230+94	60 R	6-7.5	A-1-b(0)	Sandy	0	90	8	2	NP	NP	NP	23
			8.5-10.0	A-4(1)	Sa.L./Or.	0	62	30	8	29	20	9	21
			11.0-12.5	A-4(4)	Cl.L.	0	49	27	24	21	13	8	13
75	224+40	76 L	1-2.5	A-7-6(10)	Cl./Or.&B.	0	48	16	36	44	19	25	21
76	261+56	20 L	3.5-5.0	A-7-6(14)	Clay	0	28	32	40	43	18	25	19
			6.0-7.5	A-4(2)	Sa.L.	0	58	24	18	21	14	7	17
77	265+70	3 L	3.5-5.0	A-4(2)	Sa.L.	0	58	25	17	17	12	5	13
			8.5-10.0	A-1-a(0)	Sandy	0	88	8	4	NP	NP	NP	19
78	278+66	12 R	1-2.5	A-6(7)	Cl.L./Or.	0	49	22	29	37	17	20	14
79	800+00	42 R	1-2.5	A-7-5(15)	Cl./Or.	0	42	24	34	51	18	33	15
			13-14.5	A-2-4(0)	Sa.L.	0	74	22	4	NP	NP	NP	--

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent				L.L.	P.L.	P.I.	S.L.
						Gravel	Sand	Silt	Clay				
80	832+25	42 R	2.5-4.0	A-6(9)	Cl.L.	0	37	39	24	32	16	16	--
81	845+00	42 L	6-6.5	A-4(3)	Sa.L.	0	55	27	18	22	13	9	--
82	850+00	30 L	15-16.5	A-4(2)	Sa.L.	0	60	28	12	16	11	5	--
83	854+60	CL	2.5+4.0	A-7-6(15)	Clay	0	16	42	42	44	18	26	20
			20-21.5	A-2-4(0)	Sandy	0	87	9	4	NP	NP	NP	--
84	858+75	42 L	7.5-9.0	A-4(3)	Sa.Cl.L.	0	55	25	20	22	12	10	--
85	138+50	42 L	0.0-2.5	A-6(4)	Sa.L.	0	52	36	12	30	18	12	16
			2.5-4.0	A-6(5)	Clay	0	46	24	30	30	19	11	13
86	153+00	42 R	2.0-4.0	A-7-6(16)	Clay	0	22	46	32	44	17	27	15
87	165+00	42 R	1.0-4.0	A-7-6(15)	Si.Cl.L.	0	17	55	28	44	20	24	13
88	172+75	42 L	1.5-3.0	A-2-4(0)	Sa.L.	0	73	11	16	NP	NP	NP	NP
89	179+00	42 L	5-6.5	A-6(13)	Clay	0	27	29	44	40	18	22	15
90	200+30.5	42 R	4-4.5	A-4(1)	Sa.L.	0	65	17	18	24	15	9	11
91	206+00	42 R	4-4.5	A-6(6)	Cl.L.	0	43	33	24	24	13	11	14
92	209+00	42 L	0.5-1.5	A-6(11)	Cl./Or.	0	8	61	31	35	18	17	--
			5.5-6.5	A-6(5)	Sa.Cl.L.	0	58	16	26	38	18	17	15
93	212+00	42 R	1.0-2.0	A-6(12)	Clay	0	22	43	35	40	21	19	15
			5-5.5	A-6(10)	Si.Cl.L.	0	23	55	22	31	15	16	15
94	218+00	42 R	2-3.0	A-7-6(11)	Cl./Or.	0	20	57	23	41	24	17	17
95	221+00	42 L	1-2.0	A-7-6(14)	Clay	0	18	49	33	43	20	23	17
			5-6.0	A-4(1)	Sa.L.	0	69	15	16	17	13	4	14
96	230+00	42 R	2-4.0	A-6(10)	Clay	0	35	28	37	37	19	18	16
97	239+00	42 L	4-6.0	A-6(11)	Cl.L.	0	29	46	25	35	17	18	13
98	242+00	42 R	2-4.0	A-6(6)	Cl.L.	0	41	32	27	25	13	12	13
99	257+00	42 L	9-10.0	A-7-5(20)	Cl./Or.	0	9	44	47	152	74	78	17
100	260+00	42 R	5-6.0	A-4(8)	Si.L.	0	25	57	18	23	15	8	16

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent				L.L.	P.L.	P.I.	S.L.
						Gravel	Sand	Silt	Clay				
101	261+75	42 L	0-0.5	A-6(2)	Sa.L.	0	59	24	17	29	18	11	11
			0.5-2.5	A-4(5)	Cl.L.	0	43	33	24	21	11	10	12
			3.0-4.5	A-1-b(0)	Sandy	0	85	9	6	NP	NP	NP	NP
102	273+00	42 R	1.5-6.0	A-7-6(15)	Si.Cl.	0	6	56	38	45	21	24	17
103	283+00	42 L	3.5-6.0	A-4(8)	Si.L.	0	15	68	17	28	18	10	16
104	283+50	42 R	2.0-4.0	A-7-6(17)	Clay	0	20	32	48	52	24	28	17
105	289+00	42 L	9.5-11.0	A-4(3)	Sa.Cl.L.	0	54	17	29	20	11	9	12
106	289+30	42 L	0.0-1.0	A-7-5(11)	Cl.L.	0	35	41	24	57	41	16	26
107	292+00	42 L	2.0-10.0	A-6(3)	Sa.Cl.L.	0	53	18	29	24	13	11	12
108	296+25	42 L	5.0-6.0	A-4(8)	Si.L.	0	13	77	10	24	16	8	16
109	304+00	42 L	6.0-8.0	A-6(7)	Cl.L.	0	42	33	25	28	14	14	13
110	306+60	42 L	2.0-4.0	A-7-6(15)	Clay	0	22	38	40	48	24	24	--
111	309+00	42 R	3.0-5.0	A-6(9)	Cl.L.	0	40	33	27	24	12	12	14
112	317+00	42 R	2.5-4.0	A-6(11)	Si.L.	0	31	51	18	40	20	20	16
113	331+00	42 L	4-6	A-4(3)	Sa.L.	0	58	26	16	24	15	9	13
114	352+00	42 R	0-1	A-4(1)	Cl.L.	0	32	46	22	32	24	8	20
115	358+00	42 R	4-6	A-6(8)	Cl.L.	0	47	30	23	33	18	15	14
116	379+00	42 L	0-1	A-6(6)	Loam	0	43	39	18	33	21	12	17
117	394+00	42 R	0-1.0	A-7-6(12)	Clay	0	29	38	33	43	23	20	15
118	400+00	42 R	0-1.0	A-4(8)	Si.L.	0	18	63	19	30	24	6	22
119	412+00	42 R	5-6	A-4(6)	Cl.L.	0	38	41	21	21	14	7	11
120	433+00	42 L	1-2	A-7-6(20)	Clay	0	13	46	41	63	24	39	15
121	436+00	42 R	5-5.9	A-6(8)	Cl.L.	0	39	34	27	32	16	16	13
122	439+00	42 L	0.8-2.0	A-6(9)	Clay	0	26	35	39	30	18	12	17
123	444+75	42 L	3.5-5.0	A-6(9)	Cl.L.	0	46	29	25	39	19	20	13
124	454+00	42 R	3.5-5.0	A-6(9)	Si.Cl.L.	0	24	54	22	28	16	12	24
125	472+00	42 R	5.5-6.0	A-6(6)	Cl.L.	0	48	28	24	30	17	13	14

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	 Sand	 Silt	 Clay	L.L.	P.L.	P.I.	S.L.
126	780+45	5 R	3.5-4.0	A-7-6(13)	Clay	0	21	39	40	44		20	13
127	785+24	20 L	11.5-12.0	A-4(3)	Sa.Cl.L.	0	51	28	21	21		4	14
128	794+87	16 R	5.5-6.0	A-2(4)	Sa.L.	0	74	19	7	--	--	--	--
129	799+77	22 L	1.5-2.0	A-4(7)	Si.L.	0	30	51	19	34		9	21
130	814+45	7 R	3.5-4.0	A-4(1)	Sa.L.	0	61	22	17	20		2	16
131	831+28	32 R	3.5-4.0	A-4(1)	Sa.L.	0	60	25	15	22		6	15
132	834+44	24 L	5.5-6.0	A-1-b	Sandy	0	91	5	4				
133	836+86	28 R	5.5-6.0	A-4(4)	Cl.L.	0	45	34	21	21		2	18
134	838+99	15 L	5.5-6.0	A-2-4	Sa.L.	0	75	16	9				
135	852+70	190 L	5.5-6.0	A-7-6(11)	Clay	0	32	36	32	43		20	14
136	855+23	451 R	3.5-4.0	A-4(3)	Sa.Cl.L.	0	51	27	22	30		10	15
137	856+55	23 R	9.5-10.0	A-1-b	Sa.L.	0	77	13	10	17		1	13
138	871+96	26 R	5.5-6.0	A-2-4	Sa.L.	0	77	16	7	--		--	--
139	887+26	25 L	11.5-12.0	A-1-b	Sandy	0	88	12	0	--		--	--

APPENDIX D

APPENDIX D SUBSURFACE DATA[1]

1. NE¼NW¼SW¼ sec. 14, T. 14 N., R. 2 E. Surface altitude is 743 ft (227 m). Water well (driller's log).

	Depth (ft)	
	from	to
Quaternary System:		
Clay, yellow	0	9
Clay, sandy, yellow	9	28
Mississippian System:		
Shale, blue	28	100
Shale, blue-gray	100	110

2. SW¼SW¼SW¼ sec. 12, T. 14 N., R. 3 E. Surface altitude is 755 ft (230 m). Water well (driller's log).

	Depth (ft)	
	from	to
Wisconsin Stage:		
Gravel and clay	0	21
Sand and gravel	21	34
Gravelly clay, hard	34	54
Illinoian Stage:		
Clay, sandy, green (Sangamon Stage?)	54	62
Clay, gravelly, brown	62	93
Sand	93	95
Sandy clay, brown	95	121
Pre-Illinoian Stage?:		
Sand, green (Yarmouth Stage?)	121	133
Clay, sandy, brown (Kansan Stage?)	133	143
Gravel	143	150

3. SW¼NW¼SW¼NE¼ sec. 22, T. 14 N., R. 3 E. Indiana Geological Survey auger hole at east edge of small bog; altitude of surface is 695 ft (212 m).

	Depth (ft)	
	from	to
Silt, peat, and marl	0	9
Till	9	11

4. SE¼SW¼NE¼SE¼ sec. 22, T. 14 N., R. 3 E. Indiana Geological Survey auger hole; altitude of surface is 710 ft (216 m); altitude of bottom of hole is 661 ft (203 m).

	Depth (ft)	
	from	to
Wisconsin Stage and possible pre-Wisconsin stages:		
Top soil and sandy gravel	0	30
Gravelly sand	30	35
Gravel, fine	35	37
Sandy gravel	37	43
Sand	43	49

5. NW¼SE¼NW¼ sec. 13, T. 14 N., R. 4 E. Indiana Geological Survey auger hole; altitude of surface is 900 ft (274 m).

	Depth (ft)	
	from	to
Till	0	12

6. SE¼SW¼SE¼NW¼ sec. 14, T. 14 N., R. 4 E. Indiana Geological Survey auger hole; altitude of surface is 857 ft (261 m).

	Depth (ft)	
	from	to
Top soil and oxidized till	0	20
Unoxidized till	20	34
Sand, water-bearing	34	

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[1] Localities are listed in order of increasing township numbers, increasing range numbers within tiers of townships, and increasing section numbers within each township. Location of all holes is shown on plate 3.

7. Center W½NE¼NE¼SE¼ sec. 14, T. 14 N., R. 4 E. Indiana Geological Survey auger hole; altitude of surface is 872 ft (268 m).

	Depth (ft)	
	from	to
Wisconsin Stage:		
Till and top soil, oxidized	0	12
Till, unoxidized	12	22
Till, sandy, unoxidized	22	24
Till, clayey, unoxidized	24	30

8. NE¼SW¼SW¼SE¼ sec. 14, T. 14 N., R. 4 E. Indiana Geological Survey auger hole; altitude of surface is 867 ft (264 m); altitude of bottom of hole is 813.5 ft (248 m).

	Depth (ft)	
	from	to
Till	0	54

9. NW¼NW¼ sec. 23, T. 14 N., R. 4 E., 330 ft south of north line and 990 ft east of west line. Surface altitude is 842 ft (257 m). Oil test well (modified from driller's log).[2]

	Depth (ft)	
	from	to
Quaternary System:		
Glacial drift	0	240
Devonian System:		
Shale, black	240	258
Limestone	258	380
Silurian System:		
Limestone and shale	380	532
Ordovician System:		
Limestone and shale (Cincinnatian Series)	532	1,098
Limestone (Trenton Limestone)	1,098	1,100

10. SE¼NE¼NW¼ sec. 7, T. 14 N., R. 5 E. Surface altitude is 850 ft (259 m). Water well (driller's log).

	Depth (ft)	
	from	to
Quaternary System:		
Top soil and clay	0	25
Sand and clay	25	116
Clay, blue-gray	116	184
Devonian System:		
Limestone	184	185
No sample recovered (cavern?)	185	194
Limestone	194	260

11. SW¼NE¼NW¼SW¼ sec. 22, T. 14 N., R. 5 E. Indiana Geological Survey auger hole; altitude of surface is 806 ft (248 m).

	Depth (ft)	
	from	to
Sand, becoming increasingly coarse	0	11

12. SW¼ sec. 14, T. 15 N., R. 2 E., 1,300 ft north of south line and 1,950 ft east of west line. Surface altitude is 790 ft (241 m). Oil test well (modified from driller's log).

	Depth (ft)	
	from	to
Wisconsin Stage:		
Sand and gravel	0	4
Till	4	42
Sand, water-bearing	42	44
Till	44	72
Illinoian Stage:		
Sand, bluish, water-bearing (Sangamon Stage?)	72	81
Till, brown	81	85
Sand	85	95
Till	95	135
Sand	135	156

Kansan Stage?:		
Clay, sandy	156	176
Clay, brown	176	194
Sand, coarse	194	196
Devonian System:		
Shale, black	196	292
Limestone	292	294

13. NW¼NW¼ sec. 21, T. 15 N., R. 2 E., 850 ft south of north line and 150 ft east of west line. Surface altitude is 750 ft (229 m). This log is from the well described in several old reports as "drilled one and one-half miles northwest of Bridgeport." Oil test well (stratigraphic terminology **partly** from driller's log).

	Depth (ft)	
	from	to
Quaternary System:		
Glacial drift	0	170
Mississippian System:		
Knobstone shale (Borden Group)	170	255
Devonian System:		
Genessee shale (New Albany Shale)	255	380
"Corniferous" limestone	380	520
Silurian System:		
Niagara shale	520	570
Niagara limestone	570	670

14. NW¼SE¼SW¼ sec. 23, T. 15 N., R. 2 E. Surface altitude is 790 ft (241 m). Water well (modified from driller's log).

	Depth (ft)	
	from	to
Quaternary System:		
Clay, sandy in places	0	60
Sand and clay, alternating	60	152
Mississippian System:		
Shale, blue	152	182
Shale, brown	182	190
Shale, gray	190	194
Limestone (Rockford Limestone)	194	196
Devonian System:		
Shale, black	196	316
Limestone	316	356

15. SE¼ sec. 2, T. 15 N., R. 3 E., 975 ft north of south line and 1,725 ft west of east line. Surface altitude is 710 ft (217 m). The following is a slightly modified geologist's log of Indiana Geological Survey drill hole 49.

	Depth (ft)	
	from	to
Quaternary System:		
Fill (cinders)	0	0.5
Sand and gravel; small amount of clay (gravel to a quarter of an inch diameter)	0.5	10.0
Sand and gravel, clean	10.0	19.0
Gravel unit (gravel to 1 in. diameter) at 19 ft.	....	....
Sand and fine gravel (to one-eighth inch diameter; a few thin units of coarser gravel)	19.0	50.0
Sand and gravel (to three-eighths inch diameter)	50.0	55.0
Gravel (to 1 in. diameter)	55.0	58.0
Sand, medium to coarse	58.0	70.0
Gravel (to 1 in. diameter)	70.0	73.0
Sand and gravel (to a quarter of an inch diameter)	73.0	77.0
Sand, medium to coarse (gravel to 1 in. diameter at 78 ft)	77.0	82.0
Sand, medium to coarse; small amount of gray clay (probably till)	82.0	89.0
Gravel and sand; some gray clay (probably till)	89.0	99.0
Sand, clayey, gray (probably till)	99.0	106.7
Devonian System:		
Limestone	106.7	117.2

16. NE¼ sec. 12, T. 15 N., R. 3 E., 1,380 ft south of north line and 1,760 ft west of east line. Surface altitude is 735 ft (224 m). Oil test well (condensed geologist's log).

The following is an example of the type of detailed descriptions of bedrock materials available for some of the logs that are on file at the Indiana Geological Survey. Most of the available logs are even more detailed than this one.

	Depth (ft) from	to
Quaternary System:		
Glacial drift	0	110
Devonian System:		
Limestone, white or light-gray, finely crystalline, dolomitic	110	150
Limestone, white to light-gray, finely crystalline, dolomitic, slightly sandy	150	160
Dolomite, tan to light-brown; some limestone	160	180
Dolomite, tan to brown, finely crystalline	180	200
Silurian System:		
Dolomite, white to light-gray	200	370
Dolomite, light-tan to gray, very cherty	370	400
Ordovician System:		
Limestone, light-tan to gray, mottled	400	410

17. SE¼SE¼NW¼ sec. 11, T. 15 N., R. 4 E. Surface altitude is 835 ft (255 m). Water well (driller's log).

	Depth (ft) from	to
Quaternary System:		
Gritty clay (till)	0	46
Gravel, medium-sized	46	48
Clay, hard, gritty (till)	48	60
Clay, tough, blue (till)	60	115
Clay, hard, gray, gritty (till)	115	160
Devonian System:		
Limestone, blue	160	162
Limestone, broken and gray	162	165
Limestone, gray and blue	165	250
Limestone, broken, porous	250	280
Silurian System:		
Limestone, gray	280	350
Limestone, gray and soft, "muddy"	350	355
Limestone, gray and hard	355	360
Limestone, gray and soft	360	365
Limestone, gray, hard, porous in spots	365	416

18. NW¼SE¼NW¼ sec. 6, T. 15 N., R. 5 E. Surface altitude is 849 ft (259 m). Water well (modified from driller's log).

	Depth (ft) from	to
Quaternary System:		
Wisconsin Stage:		
Clay, gray, bouldery	0	126
Sand, water-bearing	126	127
Clay, gray, gritty	127	153
Sand, "muddy"	153	156
Illinoian Stage:		
Clay, gritty, brown	156	163
Clay, gritty, gray	163	173
Pre-Illinoian Stage?:		
Clay, gritty, brown	173	203
Devonian System:		
Limestone	203	216

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[a] An electric log of this hole is on open file at the Indiana Geological Survey.

19. Center SW¼SE¼ sec. 21, T. 15 N., R. 5 E. Indiana Geological Survey auger hole; altitude of surface is 863 ft (263 m).

	Depth (ft)	
	from	to
Till	0	11
Gravel	11	24

20. Center NW¼NE¼ sec. 28, T. 15 N., R. 5 E. Indiana Geological Survey auger hole; altitude of surface is 863 ft (263 m).

	Depth (ft)	
	from	to
Sand and gravel	0	15

21. SE¼SE¼SE¼ sec. 26, T. 16 N., R. 2 E., 360 ft north of south line and 200 ft west of east line. Surface altitude is 735 ft (224 m). The following log of an oil test hole is a generalization of a more detailed record on file at the Indiana Geological Survey.

	Depth (ft)	
	from	to
Quaternary System:		
Clay, sandy	0	12
Gravel	12	22
Hardpan	22	38
Gravel	38	43
Sand and gravel	43	68
Clay, soft	68	75
Devonian System:		
Shale, black	75	196
Limestone	196	316
Silurian System:		
Limestone, shale, and dolomite	316	503
Ordovician System:		
Limestone, shale, and dolomite	503	1,064
Limestone (Trenton Limestone)	1,064	1,266

22. SW¼SW¼NE¼ sec. 15, T. 16 N., R. 3 E., 100 ft north of the south line and 100 ft east of the west line. Surface elevation is 700 ft (214 m). Oil test hole (modified from driller's log). Several detailed logs of bedrock materials for additional wells drilled in this section are on file at the Indiana Geological Survey.

	Depth (ft)	
	from	to
Quaternary System:		
Sand, yellow	0	10
Sand and gravel	10	18
Clay, soft	18	23
Devonian System:		
Limestone	23	201
Shale, blue	201	204
Silurian System:		
Limestone, hard	204	342
Shale, blue	342	351
Limestone, hard	351	365
Ordovician System:		
Limestone, soft, blue	365	385
Limestone and shale	385	725
Shale, brown	725	877
Limestone (Trenton Limestone)	877	894

23. SE¼NE¼NW¼NW¼ sec. 1, T. 16 N., R. 4 E. Altitude of surface is 750 ft (228 m). Hole drilled along highway shoulder.

	Depth (ft)	
	from	to
Sand and gravel	0	48
Till	48	..

24. NE¼SW¼NE¼ sec. 12, T. 16 N., R. 4 E. Surface altitude is 860 ft (262 m). Water well (modified from driller's log). A detailed log of Indiana Geological Survey drill hole 35, in the NE¼NW¼SW¼ sec. 18, T. 16 N., R. 4 E., is on open file at the Indiana Geological Survey. Total depth of the hole is 372.5 ft.

	Depth (ft) from	to
Quaternary System:		
Wisconsin Stage:		
Hardpan, gray and brown (till)	0	15
Hardpan, gray (till)	15	141
Illinoian Stage:		
Hardpan, green (till)	141	152
Hardpan, brown (till)	152	184
Devonian System:		
Limestone, brownish-gray	184	235
Limestone, brown	235	260
Silurian System:		
Limestone, dark-gray, hard	260	285
Limestone, gray	285	300

25. SW¼NW¼NE¼SW¼ sec. 17, T. 16 N., R. 4 E. Indiana Geological Survey auger hole; altitude of surface is 733 ft (224 m).

	Depth (ft) from	to
Sand and gravel	0	67
Till	67	75

26. NE¼NW¼SW¼ sec. 18, T. 16 N., R. 4 E. Indiana Geological Survey drill hole 35, drilled beside the Conservation Department Building at the State Fairgrounds, completed October 31, 1956. Adapted and generalized from a log prepared by John B. Patton. Altitude at surface 735 ft.

	Depth (ft) from	to
Pleistocene Series:		
Gravel	0.0	80.0
Devonian System:		
Jeffersonville Limestone:		
Limestone, white to cream, chalky to finely crystalline; some beds fossiliferous (stromatoporoids and cup corals)	80.0	110.0
Limestone, light-gray to tan, dense to chalky, locally brecciated; contains carbonaceous partings and laminations	110.0	125.9
Sandstone, light-gray, medium-grained	125.9	126.3
Limestone, gray to tan, chalky to fine-grained and dense; contains bed of dark-gray argillaceous sandstone near top and a sandy zone 2.3 ft from top; lower 2 ft laminated	126.3	136.3
Dolomite, gray-brown, finely crystalline to saccaroidal	136.3	139.7
Geneva Dolomite:		
Dolomite, light- to dark-brown, finely granular; contains network of calcite locally banded and stylolitic	139.7	149.8
Dolomite, light-brown, saccaroidal, massive; contains large calcite masses	149.8	154.6
Dolomite, brown to gray, granular; contains fossil molds and masses of white calcite	154.6	162.4
Silurian System:		
Mississinewa Shale:		
Limestone, gray, fine-grained, massive, silty; locally contains thin bands and small nodules of pyrite...	162.4	186.0

Louisville Limestone?		
(Core not recovered)	186.0	190.4
Limestone, interbedded gray-tan, finely crystalline and gray-green, fine-grained, silty	190.4	199.7
(Core missing)	199.7	208.0
Limestone, gray, granular, argillaceous; contains streaks of tan crystalline limestone	208.0	217.5
(Core missing)	217.5	221.4
Limestone, gray to light-brown; contains argillaceous partings throughout, shale bed in upper foot; fine grained to medium grained	221.4	245.4
Limestone, tan to gray, fine-grained, mottled with dark gray	245.4	268.0
Waldron Shale?:		
Limestone, light-gray, finely crystalline, faintly mottled and banded	268.0	271.7
Limestone, gray, argillaceous, fossiliferous	271.7	274.3
Laurel Limestone?:		
Limestone, light-gray, granular, dolomitic	274.3	275.9
Dolomite, dark-gray to tan, finely crystalline, stylolitic, vuggy	275.9	310.4
Osgood Formation and (or) Brassfield Limestone:		
Limestone, light-gray, fine-grained, dolomitic; lower part contains ¼-in. chert seams	310.4	311.7
Dolomite, light-gray to tan; contains abundant chert; partly saccaroidal; vuggy; glauconitic 2 to 3 ft above base	311.7	346.9
Ordovician System:		
Liberty and Waynesville Formations?:		
Shale, gray-green, fossiliferous, interbedded with limestone, tan to brown, coarsely crystalline, fossiliferous, especially *Rhynchotrema capax*	346.9	353.3
(Core not recovered)	353.3	355.7
Limestone and shale; green waxy shale interbedded with crystalline fossiliferous limestone	355.7	356.5
Shale, gray-green, calcareous, silty, massive to fissile; lower part pyritic	356.5	369.6
Limestone; gray-green argillaceous limestone interbedded with dark-gray argillaceous to finely crystalline limestone; lower 3 ft is pyritic and contains calcite-lined vugs	369.6	374.2

27. SE¼SE¼ sec. 32, T. 16 N., R. 5 E. Surface altitude is 850 ft (259 m). Water well (modified from driller's log).

	Depth (ft)	
	from	to
Quaternary System:		
Hardpan (till)	0	23
Sand	23	38
Hardpan (till)	38	111
Sand	111	112
Hardpan (till)	112	129
Sand	129	130
Hardpan (till)	130	161
Sand	161	185
"Mud," red (possibly pre-Quaternary)	185	193
Devonian System:		
Limestone	193	250

28. NE¼NW¼SE¼ sec. 34, T. 17 N., R. 2 E. Surface altitude is 862 ft (263 m). Water well (modified from driller's log).

	Depth (ft)	
	from	to
Quaternary System:		
Glacial drift	0	161
Devonian System:		
Shale, black	161	233
Limestone, white to blue	233	345
Limestone, brown	345	353

29. NE¼NE¼NE¼ sec. 19, T. 17 N., R. 3 E. Surface altitude is 860 ft (262 m). Water well (modified from driller's log).

	Depth (ft)	
	from	to
Quaternary System:		
"Soil"	0	12
Sandy gravel	12	32
Muddy sand and gravel (till)	32	79
Sand	79	82
Gravel (no water)	82	90
Muddy sand (till)	90	93
Sand	93	104
Muddy sand (till)	104	116
Devonian System:		
Shale, black	116	157
Limestone, white, hard	157	251
Limestone, white and brown	251	273
Silurian System:		
Limestone, white and gray	273	361

30. SE¼SE¼NW¼ sec. 28, T. 17 N., R. 4 E. Surface altitude is 783 ft (239 m). Water well (modified from driller's log). A detailed log of Indiana Geological Survey drill hole 14, in the NE¼NE¼NW¼ sec. 20, T. 17 N., R. 4 E., is on file at the Indiana Geological Survey. Total depth of the hole is 307.4 ft.

	Depth (ft)	
	from	to
Quaternary System:		
Till	0	15
Sand	15	25
Till	25	55
Gravel (some water)	55	57
Till	57	85
Sand	85	113
Till	113	135
Devonian System:		
Limestone	135	138

31. SW¼ sec. 20, T. 17 N., R. 5 E., 1,320 ft north of south line and 330 ft east of west line. Surface altitude is 770 ft (235 m). Gas well (modified from driller's log).

	Depth (ft)	
	from	to
Quaternary System:		
Till	0	36
Sand and gravel	36	87
Till	87	126
Gravel	126	131
Till	131	150
Sand	150	156
Clay, red (possibly pre-Quaternary)	156	188
Silurian System:		
Limestone	188	218
Shale	218	220
Limestone, blue hard	220	299
Ordovician System:		
Shale, blue	299	560
Shale, blue; limestone	560	770
Shale, brown	770	866
Limestone (Trenton Limestone)	866	870

32. NE¼NE¼ sec. 30, T. 17 N., R. 5 E., 960 ft south of north line and 1,050 ft west of east line. Gas well (condensed and simplified from geologist's log). Surface altitude is 760 ft (232 m). Detailed descriptions of the bedrock materials given in this log and of logs of holes in sec. 20 and 33 are on file at the Indiana Geological Survey.

	Depth (ft)	
	from	to
Quaternary System:		
Sand and gravel	0	9
Clay, yellow (till)	9	20
Clay, gray (till)	20	29
Sand	29	70
Gravel	70	81
Sand and gravel	81	150
Till	150	177
Sand, "soupy"	177	179
Sand, soft	179	181
Silurian System:		
Limestone	181	216
Shale	216	220
Limestone	220	292
Ordovician System:		
Shale	292	293
Limestone, soft	293	304
Limestone alternating with shale	304	485
Shale, blue	485	570
Limestone	570	576
Shale	576	680
Shale, brown	680	863
Limestone (Trenton Limestone)	863	963

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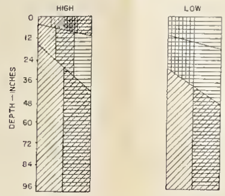
GENERAL SOIL PROFILES

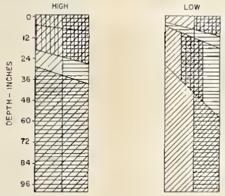
GROUND MORAINE

SILTY CLAY TEXTURE
(PROFILE SET NO. 1)



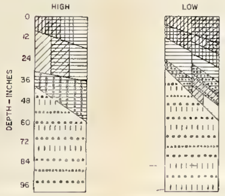
ALLUVIAL PLAINS

STRATIFIED SILTS, FINESANDS, AND CLAYS TEXTURE
(PROFILE SET NO 2)



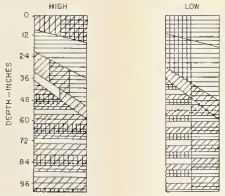
TERRACES AND OUTWASH PLAINS, KAMES AND ESKERS

STRATIFIED SAND AND GRAVEL
(PROFILE SET NO 3)



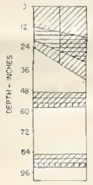
TERRACES AND OUTWASH PLAINS

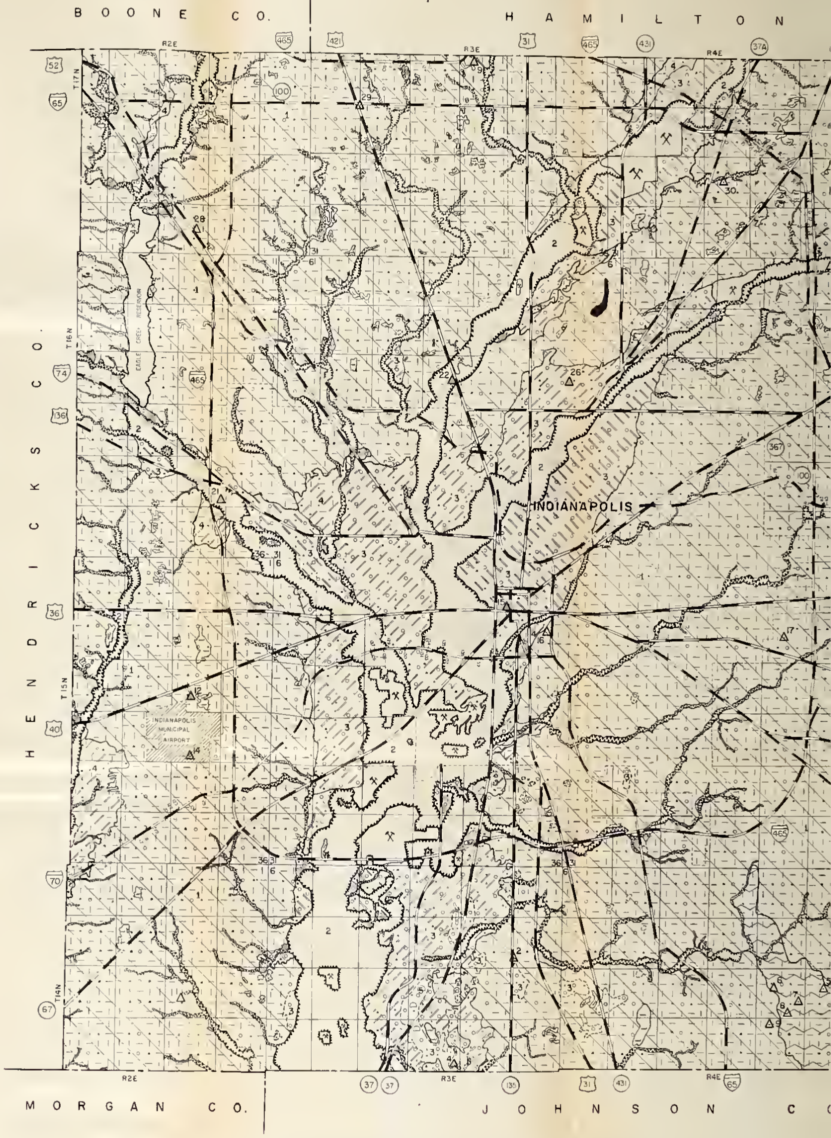
STRATIFIED SAND, SILT AND CLAY
(PROFILE SET NO 4)



INCIPIENT SAND DUNES AND SAND DEPOSITS

WINDBLOWN UNIFORM FINE SANDS
(PROFILE SET NO. 5)





ENGINEERING SOILS MAP

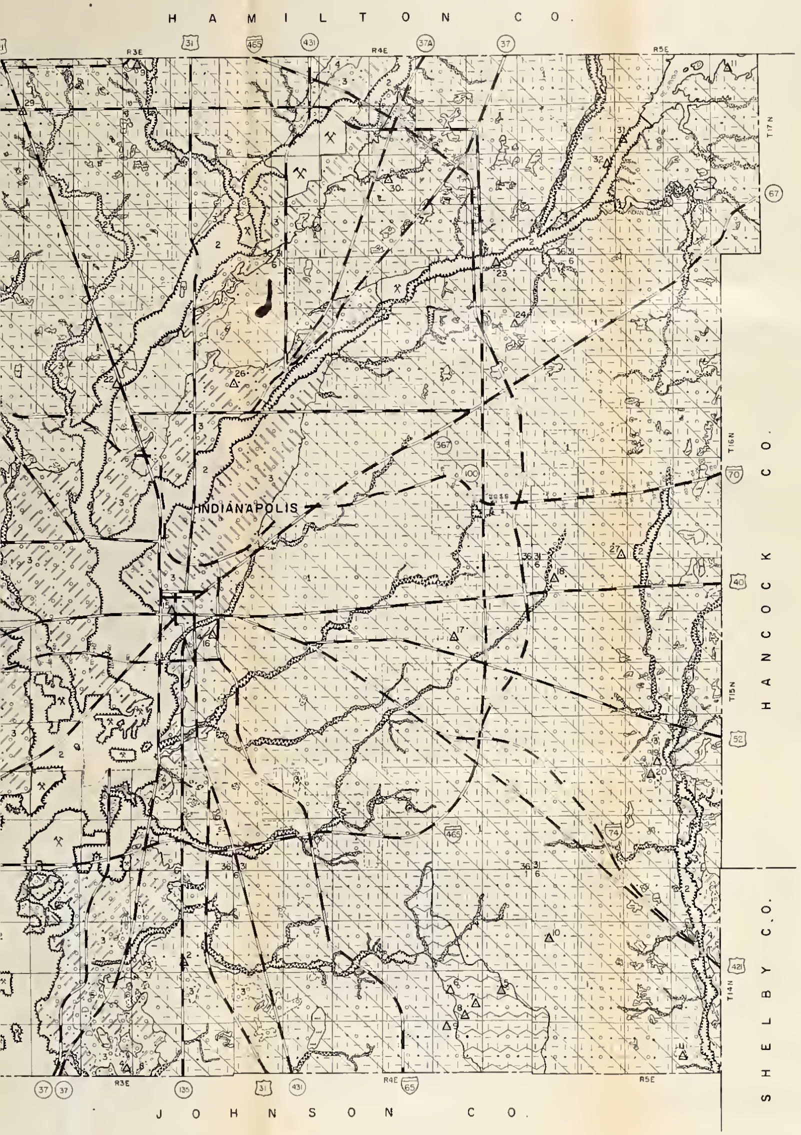
MARION COUNTY

INDIANA

PREPARED FROM
1941 AAA AERIAL PHOTOGRAPHS
BY
JOINT HIGHWAY RESEARCH PROJECT
AT
PURDUE UNIVERSITY

1976

PREPARED BY JAMES C. COSTELLO UNDER THE SUPERVISION OF R.D. MILES, PE



LEGEND

PARENT MATERIALS
(GROUPED ACCORDING TO LAND FORM AND ORIGIN)

- WISCONSIN GROUND MORAINE
- WISCONSIN RIDGE MORAINE
- ALLUVIAL PLAIN
- TERRACE
- OUTWASH PLAIN
- ESKER OR KAME
- PEAT AND MUCK
- SAND DUNE

MISCELLANEOUS

- GRAVEL PIT
  B - BORROW PIT
- HIGHLY ORGANIC TOPSOIL
- W WATER

TEXTURAL SYMBOLS
(SUPERIMPOSED ON PARENT MATERIAL SYMBOLS TO SHOW RELATIVE COMPOSITION)

- GRAVEL
- SAND
- SILT
- CLAY

TEXTURAL SYMBOLS FOR SOIL PROFILES

- GRAVEL
- SAND
- SILT
- CLAY
- LOAM

ENGINEERING SOILS MAP
MARION COUNTY
INDIANA

PREPARED FROM
1941 AAA AERIAL PHOTOGRAPHS
BY
JOINT HIGHWAY RESEARCH PROJECT
AT
PURDUE UNIVERSITY
1976

SCALE OF MILES
1 3/4 1/2 1/4 0 1 2 3 4

DRAWN BY: J.K. BUECHLER, L.E. FEHD

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